Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

ACKNOWLEDGEMENT

It is always a pleasure to remind the people that have helped and supported me not only during the drafting of my Final Project, but also during my entire time in college.

First of all, thanks to my Final Project´s director, Andrés Seco, for helping me in his office or by telephone when I have needed it.

Secondly, I would like to thanks to my classmates and friends, but particularly to Miriam Monreal, Sara León, Iñigo Barberena and Carlos Adán, who have supported and helped me during these last four years.

Finally, but not least, I would like to be thankful to my family and friends, who are also an important help and support for me.

ABSTRACT

The current project, commissioned by Gobierno de Navarra, will develop the design of a country road that will link the Murillo el Fruto I country road with Lakumulatu area in Ujué (Navarra) due to the hard and poor access which this agricultural area has. Its design will be carried out in order to ensure the correct traffic on it and to bear with the heavy loads of the vehicles that will use it. Apart from the country road itself with the required earthworks and the respective joints to the Murillo el Fruto I country road and the one in Lakumulatu area, a drainage network, consisting of a gutter system and several transversal drainage systems, will be built. During the drafting and design of this country road a special care will be taken with the environment, the natural drainage network and the surrounding lands.

KEY WORDS

Country road, earthworks, rural environment engineering, rural infrastructure, Ujué (Navarra).

RESUMEN

El presente proyecto, encargado por Gobierno de Navarra, desarrollará el diseño de un camino rural que comunicará el camino rural Murillo el Fruto I con la zona de Lakumulatu en Ujué (Navarra) debido al difícil y pobre acceso con el que cuenta el polígono agrario allí ubicado. Su diseño se llevará a cabo para asegurar el tráfico en él y para soportar las pesadas cargas de los vehículos que lo usarán. Aparte de del camino rural en sí junto al movimiento de tierras requerido y los respectivos entronques con los caminos rurales Murillo el Fruto I y el presente en la zona de Lakumulatu, una red de drenaje, compuesta por un sistema de cunetas y diversas obras de drenaje transversal, será construida. Durante la fase de diseño de este camino rural se tendrá un especial cuidado con el medio ambiente, la red de drenaje natural y las tierras colindantes.

PALABRAS CLAVE

Camino rural, movimiento de tierras, ingeniería del medio rural, infraestructuras rurales, Ujué (Navarra)

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº0: Index

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

GENERAL INDEX

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº1: Report

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. OBJECT

The prime objective of this project is to define, describe, calculate and plan all the structure needed to communicate across a country road Lakumulatu area, where the agricultural estate nº18 is located, with Murillo el Fruto I country road in Ujué (Navarra) (Plans Nº1 and Nº2). For that, the area will be studied in detail in order to find the best way to communicate both points.

The Gobierno de Navarra, through the Desarrollo Rural y Medio Ambiente department, ask to carry out a project based on the design of a country road, which will follow the formal specifications indicated in the UNE 157001: 2014.

On the one hand, in order to carry out the design of the mentioned country road, earth-grading, cut excavation and fill construction must be done according to the requirements of each section. On the other hand, in order to guarantee an adequate runoff drainage, it will be necessary to build gutters and to carry out other works in those places where necessary.

The steps to follow for the correct performance of these operations are described in this project.

Apart from all this, with the construction of this country road it is intended to facilitate the work of local farmers by improving the common scarce infrastructures they currently have. In this way, it is also going to be sought to comply with the different requirements and plans established by Gobierno de Navara, which are explained in the Background section.

2. SCOPE

This project will cover the entire design of a country road which will communicate Lakumulatu area with Murillo el Fruto I country road in Ujué (Navarra). This will include the corresponding junctions with Murillo el Fruto I country road and with the one located in Lakumulatu area. It will also remain within the scope of this project the design and calculation of various structures, such as gutters, transversal drainage systems, crowned surfaces, etc., which will have an essential role in order to avoid problems in the country road and to ensure the durability of it. However, this project will not include the entrance design of those plots that could be on the sides of the projected country road.

Although during the country road design process it will be avoided, as far as possible, to pass over private fields and agricultural plots, this project will also cover the expropriation of the affected properties.

Moreover, according to the Foral Decree 96/2006, of December 28th, and the Royal Decree 1627/97 of October 24th, the drafting of the Environmental Effects Study (Document Nº7: Environmental

Effects Study) and the Basic Safety and Health Report (Document Nº8: Basic Safety and Health Report), respectively, will be also within the scope of this project.

3. BACKGROUND

Three background types can be distinguished separately:

3.1. ADMINISTRATIVE BACKGROUND

Navarra´s Territorial Strategy (ETN) is an ambitious and innovative attempt to apply not only the principles of the European Territorial Strategy (ETE) for the first time in Spain, but also the three European Union sustainable development objectives: to achieve a greater socio-economic cohesion, to improve the conservation of natural resources and cultural heritage and to achieve a more balanced competitiveness. Territorial strategies must pursue three additional objectives in order to move towards higher and more balanced levels of well-being: to develop a polycentric and balanced urban system that, in addition, reinforces urban-rural collaboration, to achieve greater equity in access to services, infrastructure and knowledge and to efficiently manage natural and cultural heritage. Accordingly, the ETN includes a set of measures that aim to serve as a guide for the private agents and public organizations actions in Navarra in the long-term (25 years) and seek greater intersectoral coordination, from the point of view of impacts in the territory.

The ETN is used in order to develop several Land Management Plans (POT), which are instruments of territorial planning and organization of the different areas of Navarra attending to territorial homogeneity.

The corresponding POT to the Navarra´s Zona Media, where Ujué is located, states that the mentioned area, firstly, is suffering an intense population decreasing (even more in the small villages such as Ujué) and, secondly, is a region with a low tertiarization that mainly live from the agri-food activity and cultural tourism. For these reasons Zona Media´s POT is committed to improve infrastructure deficits, the reinforcement of the industrial and logistical capacity, the sector specialization in space consuming activities, effective collective transport systems and provision of services, among others (Gobierno de Navarra, 2011).

3.2. SOCIAL BACKGROUND

During the 1960s, there was an important industrial development in the Pamplona area, which gave a strong boost to mobility to the capital. The industry, services and political and administrative center concentration caused a massive residential change throughout Navarra. This had a huge impact on the rest of region, but mainly in the smallest villages.

Currently, due to rural depopulation, and as it is stated in the *2020 Navarra Territorial Inequalities Report* (Gobierno de Navarra, 2020), the following events are being observed in rural areas: population density decrease, population ageing, birth rate drop and continuous population loss.

In these rural areas the primary sector is the most important one, but, moreover, it is also a key element for Navarra´s economy. It is for all these reasons why the Gobierno de Navarra, with the aim of solving these problems, has set seven objectives: to produce decentralized employment, to promote rural spaces habitability and services improvement, to improve the different types of communications and the connectivity with other areas, to expand the knowledge facilities network (educational and technological centers), to take advantage of endogenous resources, to cooperate between the different parties and to elaborate regional strategies in line with the community strategies.

As the mentioned report indicates, the Ujué area corresponds to one of the four main hot spots where all these events are having a greater impact. Therefore, most of the efforts will go, in the first place, to these areas.

3.3. ENVIRONMENTAL BACKGROUND

In 2013 the European Union presented the Energy Roadmap for 2050, in which a competitive low carbon economy for 2050 is one of the main objectives. In that document, it is indicated that all major economies will have to reduce their emissions so that the global average temperature does not exceed 2°C in comparison with the temperature of the pre-industrial era. This Roadmap indicates that, by 2050, the European Union must reduce its emissions by an 80% below 1990 levels through domestic reductions.

In January 2018, the Gobierno de Navarra approved the *Navarra´s Energy Plan 2030* (Gobierno de Navarra, 2018) (PEN2030), in which is established that the autonomous community commits to renewable energies and a rational use of energy. One of the objectives that is indicated in that document is to promote the energy efficiency of companies, industries, shops, agriculture, services, administrations, for economic, energy saving and environmental improvement.

As the PEN2030 states, Navarra´s agriculture consumes 6,08% of the final energy (natural gas, electricity, oil and oil derivatives) consumed in all the region. Of that 6,08%, approximately an 88% is a consequence of the oil and oil derivatives consumption. Therefore, agriculture will play an essential role in the fight to achieve the goals set in PEN2030.

4. RULES AND REFERENCES

4.1. LEGAL PROVISIONS AND APPLIED RULES

At the present time there is not any Rule and/or Regulation that regulates the design and construction of country roads.

4.2. SOFTWARE

The different softwares that have been used during the country road design process are the following:

- ArcGIS 10.3: This geographical information system software was used in order to obtain the topography of the area from the 2nd LIDAR flight data obtained from the Geographical. Information National Center
- AutoCAD 2020: This computer aided design software was used in order to develop the different plans of this project.
- Aplitop MDT 7: This topographic software was used in order to design all the country road structure and to perform the earthworks volume calculation.
- Microsoft Excel 2016: This spreadsheet software was used in order to develop the different calculations required and the tables that are shown in this project.
- Microsoft Word 2016: This word processing software was used for the project´s drafting.
- TeamGantt: This project management online tool was used in order to design the Gantt Chart for the project´s planning operation.

4.3. QUALITY MANAGEMENT PLAN DURING PROJECT DRAFTING

Quality management during the project drafting will be carried out following the following rules:

- *UNE 157001:2014. General criteria for the drawing-up of the documents which make up a technical project* (AENOR, 2014)
- *UNE-ISO 10006:2018. Quality management. Guidelines for quality management in projects* (AENOR, 2018).
- *UNE-EN ISO 5457:2000. Technical product documentation. Sizes and layout of drawing sheets (ISO 5457:1999)* (AENOR, 2000).

Another project quality management element that plays a very important role is the organization of all the tasks to be carried out during the execution phase of the project. In order to manage those facts, TeamGantt will be used. In this online project management software, all the steps that must be followed during the different phases considered will be established. In this way it will be

possible to see if the deadlines are met, if the construction company is working efficiently, if the resources are enough, if every stage is adjusted to the Budget, etc.

Finally, the project will be checked to see that everything is in accordance with requirements established in UNE 157001:2014.

4.4. BIBLIOGRAPHY

AENOR. (2000). *UNE-EN ISO 5457:2000. Technical product documentation. Sizes and layout of drawing sheets (ISO 5457:1999)*. Madrid: AENOR.

AENOR. (2014*). UNE 157001: General criteria for the drawing-up of the documents which make up a technical project*. Madrid: AENOR.

AENOR. (2018*). UNE-ISO 10006:2018. Quality management. Guidelines for quality management in projects*. Madrid: AENOR.

Dal-Ré, R. (2001). *Country roads. Design and Construction* (3º ed.). Madrid: Ediciones Mundi-Prensa

Gobierno de Navarra. (2001). *Navarra´s Geological Cartography Report* (Page 207-I. San Isidro del Pinar). Pamplona: Gobierno de Navarra.

Gobierno de Navarra. (2011). *Land Management Plan: Zonas Medias*. Pamplona: Gobierno de Navarra.

Gobierno de Navarra. (2018). *Navarra´s Energy Plan 2030*. Pamplona: Gobierno de Navarra.

Gobierno de Navarra. (2020). *Navarra Territorial Inequalities Report*. Pamplona: Gobierno de Navarra.

Junta de Andalucía. (2016). *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes Catalogue*. Cordoba: UCOPress

5. TERMS AND DEFINITIONS

In the present project the following terms and definitions will be used:

5.1. TERMS

- ETN: Navarra´s Territorial Strategy
- ETE: European Territorial Strategy
- POT: Land Management Plan
- PEN2030: Navarra´s Energy Plan 2030
- UNE: Una Norma Española
- AENOR: Asociación Española de Normalización
- RCD: Construction and Demolition Wastes
- PK: Kilometric Point
- CBR: California Bearing Ratio

5.2. DEFINITIONS

-Country road: Type of communication route that is normally used to access agricultural farms or rural areas

-Zona Media: It is an intermediate region in Navarra, which shares the characteristics of the Montaña and the Ribera. With its transitional landscape, it softens and attenuates the great geographical and physical contrasts of the Montaña and the Ribera. Two areas can be distinguished, Navarra Media Oriental and Tierra Estella.

-Kilometric Point (PK): Term used to provide to provide a reference of the position of a point alongside the axis of a highway, road, country road, ditch, pipeline, etc. The PK is indicated in the following way: PK A + BCD,EFG, being A the whole number of km from the origin of the way to a given point and BCD,EFG the number of m left. The way starts in a PK initial or PK 0 and it ends in a PK final.

-Slope: It is a way to measure the terrain inclination. In this project, three different ways of expressing the slope have been used. The first of them, which is used to determine the cut and fill slopes, is through a HD/VD fraction, where HD is the horizontal distance and VD the vertical distance that make up the slope. The second of them, that is used to determine the longitudinal and transversal slope of the country road, is through a %, which is the height variation expressed in meters in a horizontal distance equal to 100 m. The third of them, that is used to determine the transversal drainage system slope, is through inclination degrees, which is a measure of the vertical angle formed by the slope and the horizontal plane

-CBR: It is a punching test that is carried out on a soil, inserted in a cylindrical mold six inches high and five in diameter, in saturated conditions, after being immersed in water for four days. This test consists of forcing a cylindrical piston of 19,35 cm^2 section to penetrate soil

sample at a constant and uniform speed of 1,27 mm/minute and measure the necessary load so that it penetrates to 2,54 mm depth.

-Grade line: It is the line that determines the height and slopes that the country road will finally take on the modified ground.

-Subgrade: It is the land area actually occupied by the country road. This is the leveled layer where the pavement is settled, which is made up of the material with which the fills have been executed or that has been left exposed, once the cut excavation operations have been carried out.

-Cut: Part of the country road located under the original terrain. It is also the earthwork operation which is carried out in order to lower the land height.

-Fill: Part of the country road located over the original terrain. It is also the earthwork operation which consists of the extension and compaction of land from the excavations.

-Pavement: It is the country road area for vehicle circulation. It is made by a series of granular materials layers with a certain thickness.

-Ballast materials: Mix of aggregates, totally or partially crushed, in which the granulometry of all the elements that compose it is continuous.

6. DESIGN REQUIREMENTS

6.1. PROMOTER REQUIREMENTS

The county road designed must connect Lakumulatu area with the rural road Murillo el Fruto I. During the last decades, the agricultural estate nº18 farming community (which corresponds to Lakumulatu area) has complained about the poor access that they have to their agricultural plots. It is therefore important to ensure that the new country road will be useful and as short as possible in order to help, in the first instance, to the farmers and, secondly, to the environment.

The promoter established that the country road must have a width of 4 m. This will allow to drive tractors with implements in a comfortable way. Although the country road will be used in both traffic systems the with will remain being equal to 4 m. In this way, in the event in which two vehicles were found, they, by themselves, would have to agree how to continue driving, however, it is considered ‘unusual’ for this fact to occur.

As far as the earthworks are concerned, and with the aim of causing the least possible visual impact, the promoter asked to minimize as far as possible the volume of modified ground.

The final result must lead to the least environmental impact. For that reason, the Desarrollo Rural y Medio Ambiente department has decided to apply for the first time the pavement dimensioning methodology suggested by the Junta de Andalucía's Obra pública Agency and the University of Cordoba in the *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes (RCD) Catalogue* (Junta de Andalucía, 2016). Therefore, this country road will be used as a pilot trial. In the case of being satisfied with the final result, this could be used as an example to improve the Navarra´s country road network in a sustainable and environmental-friendly way.

Otherwise, as far as the other design requirements are concerned, the promoter established that the designed country road must be equipped with the drainage system needed to, firstly, avoid problems during the drive and, secondly, extend the useful life of the way.

6.2. EXTERNAL REQUIREMETNS

Most of the farmers that have their plots in Lakumulatu area live in Ujué or in Murillo el Fruto. Currently, given the poor country road network, they have to drive 11,4 km in order to arrive to the village of Ujué or 21,9 km in order to arrive to the village of Murillo el Fruto. That is the reason why they have let know several times to Gobierno de Navarra that they need a better access to their plots. This will result essential for them in order to improve their performance efficiency and consequently to improve profit margins which, in the agriculture sector, are very tight.

6.3. SURROUNDINGS REQUIREMENTS

The designed country road must be executed according to the geotechnical characteristics of the area, which are described *Navarra´s Geological Cartography Report* (Page 207-I. San Isidro del Pinar) (Gobierno de Navarra, 2001). Besides of that, the country road must respect the hydrology of the area. Therefore, it should not affect other infrastructure or nearby plots. In addition, the country road will be as respectful as possible with the environment of the area, occupying the least possible space and minimizing the impacts that it could cause.

7. SOLUTION ANALYSIS

Among all the alternatives that were studied and considering that the main objective was to communicate the two pre-existing country roads in order to reduce the distance of the Lakumulatu agricultural area to the closest villages, the one that was chosen was the most suitable one. The other studied alternatives involved the permanent occupation of larger area and more agricultural plots, the modification of the pre-existing country roads axis, the earthwork volume increasement

and its subsequent increase in visual impact, a larger area to clear, etc. For that reason and taking into account the requirements imposed for this project, the actual drafting was selected.

8. END RESULT

8.1. COUNTRY ROAD OVERVIEW

The country road Kilometric Point (PK) PK 0 will be in Murillo el Fruto I country road, but more specifically in the (627327,57N, 4701613,20E)[1] point and it will end in the country road that goes across all the Lakumulatu area, in the (626586,00N, 4701845,71E) point (Plan Nº3). Throughout all the course, the country road must rise 155 m, which is the height difference that there is between the PK initial in Murillo el Fruto I country road, whose altitude is 479,25 m, and the PK final in Lakumulatu area, whose altitude is 634,25 m. With this new country road, which will be 2254,562 m in length, the distance from the agricultural area to Ujué will be equal to 9,3 km (instead of the 11,4 km that were previously) and to Murillo el Fruto equal to 13,1 km (instead of the 21,9 km that were previously).

For the general design, the method presented by Dal-Ré was used as main reference.

Firstly, the axis was plotted (Plan Nº3). For that, the main criterion was to make as few alignments as possible along the whole country road or, what is the same, to make the fewer number of bends as possible. With respect to the radius of the country road bends, as the country road is not going to have an asphalt coating, the following formula was used: $R_{min} = 0{,}026 \times v^2$ (Dal-Ré, 2001), being Rmin the minimum bend radius in m and v the maximum bend velocity in km/h. In this way, sufficient visibility and correct circulation across the bends can be ensure, without the risk of transverse sliding or overturning created by the centrifugal force (Dal-Ré, 2001). Besides, as the country road had to rise 155 m from its beginning, the country road had to present an intense slope along all its way up. For so, and with the aim of trying to minimize the earth-works volume, as established by Gobierno de Navarra, an average slope of 7% for the grade line was chosen. It is not convenient that the country roads present slopes above 7-8%. Even though tractors with a trailer or with an implement can go up along steeper slopes, they can have serious problems when going down, especially when they are loaded and the pavement is wet (Dal-Ré, 2001). However, and to comply with the aforementioned requirement imposed by Gobierno de Navarra, this figure may be exceeded up to 10%, but in sections up to 250 m in length and with a lower slope in the previous and subsequent sections (Dal-Ré, 2001).As far as the transitions between the different slopes of the grade line are concerned, and taking into account the future use of country road, circular type transitions were chosen. These were designed in order to prevent ‘take off’ and ‘clash’ effects and to ensure enough visibility at different sign slope changes. The design and dimensioning of the transitions was carried out by the designer individually for each of them as it can be checked in the Plan Nº4. As a result of the combination of alignments, bends and slope changes, an axis of

[1] All the coordinates shown in this project will be given for ETRS89 / UTM Zone 30N

2254,562 m in length was achieved. This result was accepted by the promoter, since the minimum length that the country road should had have (taking into account the average slope fixed for the design and the difference in height) was 2214 m.

Secondly the cross-section of the country road and its surroundings was designed (Plan Nº5 and Nº6). For that, in the first instance, a crowned road was chosen. It is recommended that the transversal slope must be above 1,5%, in order to facilitate surface drainage and below 3%, in order to ensure the traffic (Dal-Ré, 2001). Based on that criterion, in the designed country road a 2% transversal slope was chosen for the crowned section, which edge will be in the middle of the 4m wide pavement. In the second place the slopes of the cut and fill were fixed. These slopes were studied according to the geotechnical characteristics of the soils that form them, which are described in the *Navarra´s Geological Cartography Report* (Page 207-I. San Isidro del Pinar) (Gobierno de Navarra, 2001). According to that document, in the studied area, "when the disposition of the materials is transverse to the orientation of the slopes, and their dip is greater than the slope, no instability phenomenon is observed. On the other hand, the nature of these materials, in terms of their resistive parameters and alternating arrangement, does not favor the appearance of landslides. There is only a risk of block-falling from the sandy ridges in those areas where there are pseudo vertical or cantilevered scarps due to the uneven lower shale levels". Considering the circumstances explained above, it was decided to use a 3/2 slope for the cuts and a 2/1 slope for the fills along almost all the country road. However, and with the aim of trying to minimize the earth-works volume, it was decided to modify the slope in ten sections, taking always as reference those values described by Dal-Ré (Dal-Ré, 2001). The first of them occupied the section between the PK 0+149 and the PK 0+200, in which a 1/1 slope was used for the cut. After that a 10m segment was used as a transition in order to return to the standard 3/2 cut slope. The second of them occupied the section between the PK 0+962,5 and the PK 1+010, in which a 1/1 slope was used for the cut. After that a 10m segment was used as a transition in order to return to the standard 3/2 cut slope. The third of them occupied the section between the PK 1+270 and the PK 1+300, in which a 1/1 slope was used for the cut. Before that a 10m segment was used as a transition in order to return to the standard 3/2 cut slope. The fourth of them occupied the section between the PK 2+110 and the PK 2+170, in which a 1/1 slope was used for the cut. The fifth of them occupied the section between the PK 0+535 and the PK 0+625, in which a 3/2 slope was used for the fill. The sixth of them occupied the section between the PK 0+890 and the PK 0+960, in which a 3/2 slope was used for the fill. Before that a 10m segment was used as a transition in order to return to the standard 2/1 fill slope. The seventh of them occupied the section between the PK 1+165 and the PK 1+200, in which a 3/2 slope was used for the fill. The eighth of them occupied the section between the PK 1+410 and the PK 1+425, in which a 3/2 slope was used for the fill. The ninth of them occupied the section between the PK 1+665 and the PK 1+725, in which a 3/2 slope was used for the fill. After that a 10m segment was used as a transition in order to return to the standard 2/1 fill slope. Finally, the tenth of them occupied the section between the PK 2+180 and the PK final, in which a 3/2 slope was used for the right fill. As far as all the fills of this country road are concerned, they will be made up of the cut excavated terrain, nevertheless, as the amount of land excavated was much greater than the amount of land needed for the fills construction, the corresponding waste management plan was carried out to get rid of the excavation surplus, as well as other waste generated on the site (Appendix Nº6: Waste Management Plan). In the third place, considering the

California Bearing Ratio (CBR) value of 4,4, indicated in *Navarra´s Geological Cartography Report* (Page 207-I. San Isidro del Pinar) (Gobierno de Navarra, 2001) for that area, and following the chosen pavement dimensioning methodology, for a E1 grading and for a T422 traffic category (calculated in the Appendix Nº1: Traffic category), a pavement section composed, from the bottom up, by 30 cm of recycled RCD selected soil (SR-SEL), 20 cm of mixed recycled artificial ballast type I (ZARM I) and 20 cm of concrete recycled artificial ballast was obtained (ZARHor) (as it is explained in the Appendix Nº2: Pavement dimensioning).

Thirdly, the drainage system of the country road was outlined. In the first place, a gutter system was designed. They will be uncoated gutters that will be arranged to the pavement at the point in which the base joins the subgrade and they will be 0,5 m deep and 1,4 m wide with a 2/1 inner slope and a 4/5 outer slope. These gutters will be only disposed under the cut segments in order to prevent upslope runoff from flooding the country road. In the second place, as the country road will present a crowned section, the country road surface drainage will take place by gravity to the sides of the road. In the case of being in a cut segment, the water will be poured into the gutter, on the other hand, in the case of being in a fill segment, the water will fall down the hill. The fill, just like the gutter, will start at the point in which the base joins the subgrade. This, together with the geometry that the section will present, will help to drain quickly water from the pavement, which will avoid problems in the base. In the third place, fourteen transversal drainage systems were disposed along the country road sides. They were placed in those points in which water could have caused problems due to its accumulation and/or in areas where the country road interrupted the natural water flow (Plan Nº7.2). These transversal drainage systems are made up of one reinforced concrete well (two in the case of the transversal drainage system number 7), a reinforced concrete 400 mm diameter pipe and a reinforced concrete wingwall for the aforementioned pipe. The shape and dimensions of all these elements can be checked in the Plan Nº9. In the fourth place, the entire Lakumulatu´s hillside, as well as the country road and its occupation area, was divided into different basins (Plan Nº7.1) in order to study the water release. These, together to their drainage points and the different transversal drainage systems are studied in detail in the Appendix Nº3: Hydrology and hydraulics.

Fourthly, the attachments with the other country roads were designed. As neither of the pre-existing country roads had to be subjected to alteration, the grade line of the designed country road had to begin and end in the same height as the other two. Moreover, the cross-section of the designed country road in the attachment areas were modified with respect to the section used throughout the entire way so that they adapted to the sections of the pre-existing country roads. The shape, dimensions and layout of the attachment areas can be checked in the Plan Nº5 and Nº6. As far as the attachment with the Murillo el Fruto I country road is concerned, the designed country road pass over its gutter so, by implication, a transversal drainage system was disposed just before it. This system, unlike the others, will not go under the designed country road, since it will go under the Murillo el Fruto I country road. Consequently, on this preexisting country road the corresponding excavation and covering operations will have to be carried out. Besides all the aforementioned factors, a P50 signal will be installed in each of the attachments with the other country roads. Their location will be chosen once the work has been finished in order to settle them

in the most suitable places. In this way future users of the country road will be warned of risks that could arise when driving on it to prevent problems and/or accidents

Finally, once all the country road´s infrastructure was designed and plotted, a final occupancy area equal to 4 ha was obtained. With that area the expropriation process was carried out as it is shown in the Plan N8 and in the Appendix Nº4: Expropriations.

As far as the execution of the works, quality of the materials and final results are concerned, the provisions established in the Document Nº4: Requirements Document will be followed.

All the modifications that the Lakumulatu´s hillside will undergo, as well as some photographs of the area, can be seen in Appendix Nº7: Graphic Appendix

8.2. SUMMARY BUDGET

The summary Budget can be checked below in the Table 1. All the data and calculations corresponding to this table can be verified in the Documents Nº5: Measurements and Nº6: Budget.

Table 1: Project´s summary Budget

Chapter	Full amount (€)
SUMMARY BUDGET	
MATERIAL EXECUTION BUDGET (PEM)	
CHAPTER 1.- EARTHWORKS	79555,400
CHAPTER 2.- DRAINS	14889,349
CHAPTER 3.- PAVEMENT	37109,070
CHAPTER 4.- SIGNALING, BEACONING AND DEFENSES	310,200
CHAPTER 5.- WASTE MANAGEMENT	36075,15
SAFETY AND HEALTH	20000,000
TOTAL PEM	187939,169
CONTRACT EXECUTION BUDGET (PEC)	
10% OVERHEAD COSTS	18793,9169
6% INDUSTRIAL PROFIT	11276,35014
TOTAL PEC	218009,436
GENERAL BUDGET	
21% IVA	45781,98157
TOTAL GENERAL BUDGET	263791,42

The works object of the "Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)" project have a total Budget amounting to TWO HUNDRED AND SIXTY-THREE THOUSAND SEVEN HUNDRED AND NINTY-ONE euros with FOURTY-TWO cents (263791,42 €), including IVA.

As far as the work unit and operation prices are concerned, all the information can be checked in the Appendix Nº5: Price Justification

9. PLANNING

Project planning is carried out through processes, which are a group of activities that are interrelated between them. In order to carry out this process, the hole work operating phase was divided into seven different stages: construction from PK 0+000 to PK 0+500, construction from PK 0+500 to PK 1+000, construction from PK 1+000 to PK 1+500, construction from PK 1+500 to PK 2+000, construction from PK 2+000 to PK 2+254,500, final operations and final checking.

As far as the five first stages are concerned, all of them will have the same operations: clearing and topsoil removal, earthworks, drainage elements construction and installation and pavement construction. For the clearing and topsoil removal operation, as the contractor will probably use large machinery, it will be done continuously for the five stages. Since the total area to work is equal to 4 ha, it is estimated that this process will take 5 days. For the earthworks operation, which can not start until the previous one has been carried out for that section, it has been estimated that 40 m of the future country road will be worked every day, therefore, this operation will last 13 days for each stage, unless in the fifth stage in which it will last 6 days. For the drainage elements construction and installation operation the same duration as for the previous operation has been estimated, since both will be carried out together. For the final operation of these stages, which consists in the pavement construction, it has been estimated that 40 m of the future country road will be worked every day, therefore, this operation will last 13 days for each stage, unless in the fifth stage in which it will last 6 days. It will be important that this operation is carried out once the concrete curing process has advanced enough, in the opposite, this operation must be carried out carefully. Considering this last point and with the aim of trying to advance the work, this operation will start 8 days after the beginning of the other two previous operations. As far as the last two operations are concerned, each one is estimated to last one day

In order to be able to manage all these operations in advance, a Gantt chart was plotted with TeamGantt (Figure 1), which will be very useful to check if the deadlines are met, if the construction company is working efficiently, if the resources are enough, if every stage is adjusted to the Budget, etc.

The beginning of the works will take place on September 7th, 2020, the date by which all the corresponding permits and licenses must be available. On the other hand, if no inconveniences of any kind arise and all operations are carried out as planned, the work will end 73 days later, on November 19th, 2020, after its revision.

10. ORDER OF PRIORITY BETWEEN THE DOCUMENTS

In order to avoid discrepancies between the basic project documents, the following order of priority has been established between them:

1º Plans
2º Requirements Document
3º Budget
4º Report

Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)

	start	end
Construction from PK 0+000 to PK 0+500	**07/09/20**	**29/09/20**
Clearing and topsoil removal	07/09	07/09
Earthworks	08/09	21/09
Drainage elements construction and installation	08/09	21/09
Pavement contruction	16/09	29/09
Construction from PK 0+500 to PK 1+000	**08/09/20**	**13/10/20**
Clearing and topsoil removal	08/09	08/09
Earthworks	22/09	05/10
Drainage elements construction and installation	22/09	05/10
Pavement construction	30/09	13/10
Construction from PK 1+000 to PK 1+500	**09/09/20**	**27/10/20**
Clearing and topsoil removal	09/09	09/09
Earthworks	06/10	19/10
Drainage elements construction and installation	06/10	19/10
Pavement construction	14/10	27/10
Construction from PK 1+500 to PK 2+000	**10/09/20**	**10/11/20**
Clearing and topsoil removal	10/09	10/09
Earthworks	20/10	02/11
Drainage elements construction and installation	20/10	02/11
Pavement construction	28/10	10/11
Construction from PK 2+000 to PK 2+254.500	**11/09/20**	**17/11/20**
Clearing and topsoil removal	11/09	11/09
Earthworks	03/11	09/11
Drainage elements construction and installation	03/11	09/11
Pavement construction	11/11	17/11
Final operations	**18/11/20**	**18/11/20**
Signals installation	18/11	18/11
Final inspection	**19/11/20**	**19/11/20**
Inspection and checking	19/11	19/11

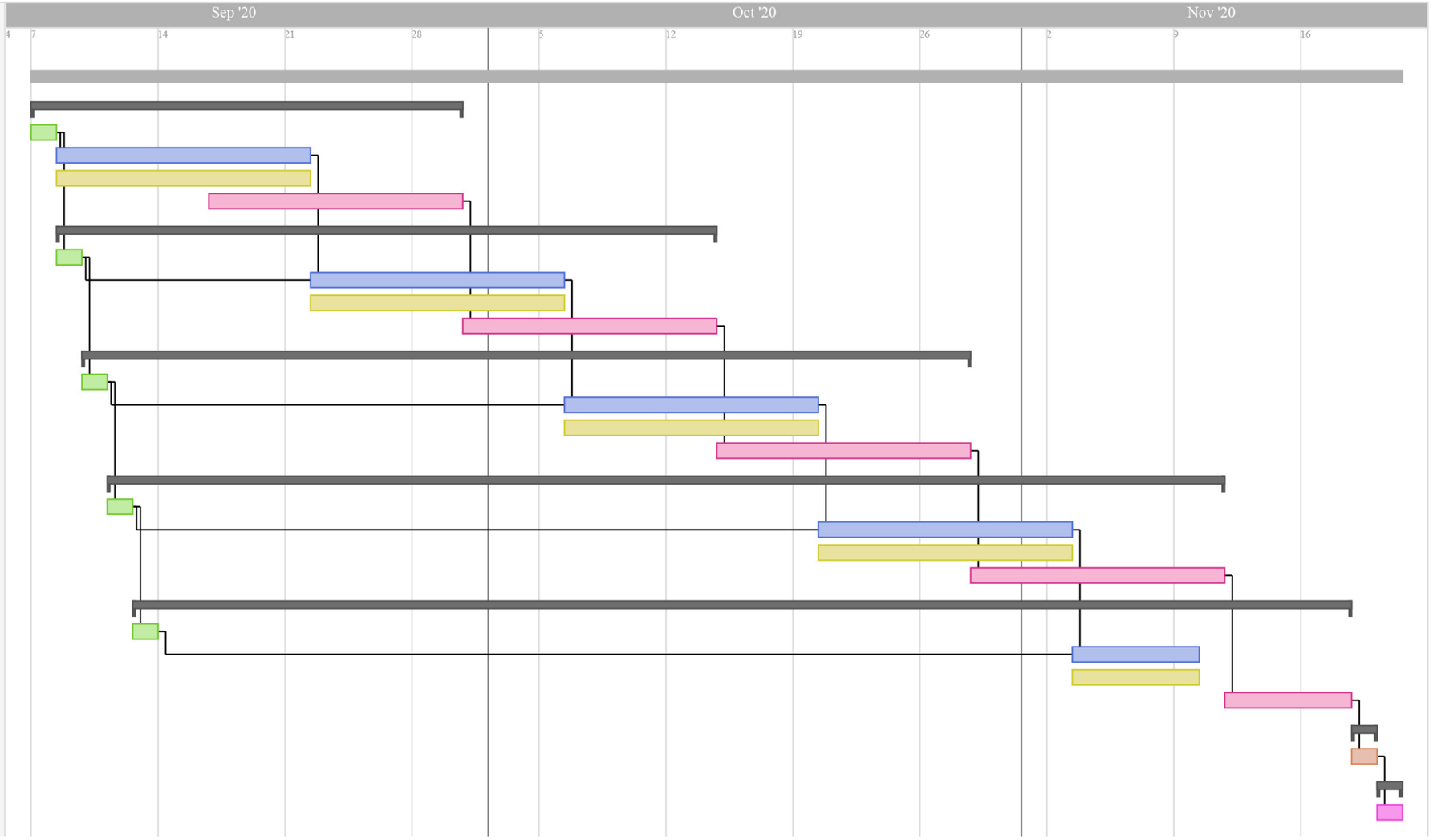


Figure 1: Project´s construction phase planning

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº2: Appendices

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Appendix Nº1: Traffic Category

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

The aim of the current appendix is to determine the traffic that the country road must stand. Logically, traffic on rural roads depends on the management and operations carried out in the different plots to which it gives access. That is the reason why traffic is considered seasonal.

As the traffic data is very poor, measuring the traffic in country roads is not an easy task. That is the reason why an estimation is carried out. The intensity of heavy vehicles will be exclusively considered for the project, since they are the ones that really transmit loads that can deteriorate the base. Consequently, the Average Daily Intensity index (IMD) will be used for that estimation.

2. IMD CALCULATION

IMD is the Average Daily Intensity of Heavy Vehicles that drives along the country road. In order to calculate the IMD, without having gauging data, the empirical formula suggested in the *Irrigated lands engineering manual* (Heras, 1981) was used:

$IMD = Q \times S \times E^{0,5} \times K/500$

Where:

Q: Gross annual production of the area (t/ha)

S: Agricultural area to which the country road gives access (ha)

E: Number of different plots

K: Coefficient determined according to the characteristics of the country road. It can be:

- K=1: For terminal country roads whose end does not link with another path
- K=1,3: For country roads that joins with another paths
- K=1,5: For country roads that communicate with a population or with a village

IMD: Number of heavy vehicles on the entire country road during a production year equal to Q.

As far as the studied area is concerned, it presents the following values:

Lakumulatu area, from an agricultural point of view, is an area where cereal predominates. However, it must be considered that there are some other crops such as, fodder or almond trees. Consequently, taking into account the crops that are grown over that area and the data offered by UAGN, a gross annual production equal to 6t/ha will be assigned for that area.

The designed country road will give access to almost all the Ujué´s agricultural estate nº18. However, it must be considered that a great deal of that land are rangelands. Consequently, taking into account that, an agricultural area of 20 ha will be considered as the area to which the country road gives access.

Over the Lakumulatu area there are many and varied agricultural plots. Although the Ujue´s agricultural estate nº18 has 361 different plots, some of them are not productive plots itself and some others will not be accessible by the designed country road. As a consequence of that, it will be considered that over the 20 ha to which the country road gives access, there are 300 different agricultural plots.

The designed country road join with two different country roads. Consequently, the coefficient determined according to the characteristics of the country road will be equal to 1,3

Consequently:

$IMD = 6 \times 20 \times 300^{0,5} \times 1,3/500 = 5,40$ heavy vehicles/day

3. RESULTS

As the IMD is equal to 5,4 heavy vehicles/day, according to the classification determined in the *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes (RCD) Catalogue* (Junta de Andalucía, 2016), the traffic category of the designed country road will be the T422 category, which allows between 5 and 14 heavy vehicles per day.

4. REFERENCES

Heras, R. (1981). *Irrigated lands engineering manual*. Madrid: MOPU

Junta de Andalucía. (2016). *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes Catalogue*. Córdoba: UCOPress

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Appendix Nº2: Pavement Dimensioning

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

The aim of the current appendix is to size the country road´s pavement. For that, the best base set between the different ones that are shown in the *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes (RCD) Catalogue* (Junta de Andalucía, 2016) will be chosen, taking into account the subgrade, the traffic category, the work units and its cost.

2. PAVMENT DIMENSIONING PROCESS

For the drafting of this appendix several data were considered:

Firstly, taking into account the geotechnical data offered in *Navarra´s Geological Cartography Report* (Page 207-I. San Isidro del Pinar) (Gobierno de Navarra, 2001), it can be seen that the area where the country road is going to be built has a CBR value of 4,4. According to the selected pavement dimensioning method, on country roads, the quality of the subgrade is evaluated through the CBR test and not through the loaded plate test as in the Rule 6.1 -IC Firm sections, of the Road Instruction. In the chosen method the following classification is carried out (Table 2):

Table 2: Subgrade classification according to *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes (RCD) Catalogue* (Junta de Andalucía, 2016)

Subgrade category	CBR
E1	$5 \leq CBR < 10$
E2	$10 \leq CBR < 20$
E3	$CBR \geq 20$

Although the CBR value of the studied area is not included in the table showed above, the method states that in the event in which the subgrade had a CBR value below 5, a 30 cm natural or recycled RCD selected soil layer will be placed on it. In this way, the E1 subgrade category is considered reached. Therefore, the subgrade category on which the country road will be constructed is E1.

Secondly, considering the E1 subgrade category that the country road will have and the T422 traffic category previously calculated in the Appendix Nº1: Traffic Category, the base section was sized. For that, the chosen method offered 4 possibilities (Figure 2):

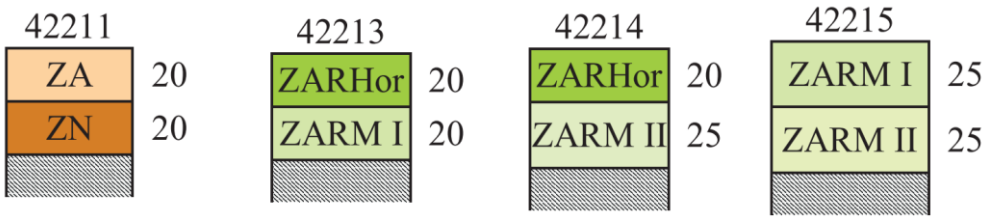


Figure 2: Base sections suggested in *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes (RCD) Catalogue* (Junta de Andalucía, 2016) for a E1 subgrade and a T422 traffic category

Finally, after having assessed the 4 possibilities offered by the *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes (RCD) Catalogue* (Junta de Andalucía, 2016), the base section number 42213 was chosen. That option was chosen due to the following reasons: in the first place because the 100% of its section is made of RCD material and in the second place because, among the options that meet the first condition, is the option that uses less material.

3. RESULTS

Consequently, the base section that the designed country road will have is going to be made, from the bottom up, by 30 cm of natural or recycled RCD selected soil, 20 cm of mixed recycled artificial ballast type I and 20 cm of concrete recycled artificial ballast was obtained.

4. REFERENCES

Gobierno de Navarra. (2001). *Navarra´s Geological Cartography Report* (Page 207-I. San Isidro del Pinar). Pamplona: Gobierno de Navarra.

Junta de Andalucía. (2016). *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes Catalogue*. Córdoba: UCOPress

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Appendix Nº3: Hydrology and Hydraulics

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

The purpose of this appendix will be to carry out a hydrological study of the Lakumulatu´s hillside catchment area according, mainly, to the method suggested by the Transport, Mobility and Urban Agenda Ministry in the Rule 5.2-IC Surface Drainage of the Road Instruction and in the *Hydrometeorological calculation of maximum flows in small natural basins* (Roads General Directorate, 1987). Rainfall, intensities, return periods associated with it and the flows generated after an episode of rain will be analyzed. After that, it will be analyzed if the gutters and other drainage elements are enough and correctly dimensioned from a hydraulic point of view.

2. HYDROLOGY OF THE AREA

Firstly, over the Lakumulatu´s hillside were the country road will be settled; the different catchment areas were identified. As a result of this division of the area and as it can be seen in the Plan Nº 7, 33 catchment areas were obtained.

Secondly, the data of the closest meteorological station to the basin was obtained from MeteoNavarra. In this case, although there is another meteorological station in Ujué, the Carcastillo (La Oliva) one was chosen for this study, since it is the closest manual station or, in other words, the closest meteorological station with a larger data series. For this study the precipitation data from the las 30 years was downloaded. For each year, thirdly, both the maximum daily precipitation and the annual accumulated precipitation were selected and calculated. Fourthly, all climate series of each year were analyzed in order to clean the years where lack of data was registered (Table 3).

Table 3: Precipitation data registered in the Carcastillo (La Oliva) meteorological station from 1969 to 2019

YEAR	MAXIMUM ANNUAL DAILY PRECIPITATION (mm)	ACCUMULATED ANNUAL PRECIPITATION (mm)	LACK OF DATA (months)	CLEANED MAXIMUM ANNUAL DAILY PRECIPITATION (mm)
1969	27	560	D	
1970	27	361,9		27
1971	56,5	619,6		56,5
1972	40	545		40
1973	29	357,7		29
1974	45	456,3		45
1975	46	570		46
1976	27,2	196,7	E-A	
1977	27,5	62,7	F-D	
1978	-	-	E-D	
1979	-	-	E-D	

YEAR	MAXIMUM ANNUAL DAILY PRECIPITATION (mm)	ACCUMULATED ANNUAL PRECIPITATION (mm)	LACK OF DATA (months)	CLEANED MAXIMUM ANNUAL DAILY PRECIPITATION (mm)
1980	-	-	E-D	
1981	26,5	296,2	E-M	
1982	34	360,8	D	
1983	-	-	E-D	
1984	55,6	556,4	E	
1985	23,9	333		23,9
1986	33,5	373,5		33,5
1987	36	455,5		36
1988	46,5	523,5		46,5
1989	25,5	382,5		25,5
1990	28	383,5		28
1991	37,8	493,5		37,8
1992	61,2	526,8		61,2
1993	30,7	415,7		30,7
1994	25,3	397,8		25,3
1995	25	373,6		25
1996	38,6	493,4		38,6
1997	37,9	547,3		37,9
1998	70	390,9		70
1999	35	437,6		35
2000	43,5	483,4		43,5
2001	23	315,3		23
2002	18	405,7		18
2003	83	726,1		83
2004	33	520,7		33
2005	51,8	458		51,8
2006	71	547,4		71
2007	37	484,9		37
2008	57	603		57
2009	53,5	426,5		53,5
2010	48,2	397,8		48,2
2011	55,8	379,3		55,8
2012	57,5	390,6		57,5
2013	51,5	629,3		51,5
2014	33,3	498,4		33,3
2015	39,3	434,4		39,3
2016	34	458		34

YEAR	MAXIMUM ANNUAL DAILY PRECIPITATION (mm)	ACCUMULATED ANNUAL PRECIPITATION (mm)	LACK OF DATA (months)	CLEANED MAXIMUM ANNUAL DAILY PRECIPITATION (mm)
2017	28,5	490,6		28,5
2018	51,7	712,2		51,7
2019	43	398,9		43

Once this data was cleaned, in the fifth place, the maximum daily rainfall from lowest to highest were ranked. Then, sixthly, the mean m_x and the standard deviation s_x of the data set of the maximum daily precipitation were calculated and, after that, the α and u parameters of the Gumbel Method were also calculated.

$$\alpha = 6^{0,5}/s_x * \pi$$

$$u = m_x - 0,5772 * \alpha$$

Seventhly, the probability distribution function F(x), the return period T and the limited variable y were calculated:

Distribution function by Weibull method: F(x)= i/(N+1)
i: Order
N: Total number of values

Return period: T=1/(1-F(x))

Reduced variable: y = -Ln (Ln(1/F(x)))

With all this (Table 4), in the eighth place the maximum daily rainfall was represented in a scatter plot based on their return period in the Figure 3 in the so-called Observed Values curve.

Table 4: Ranked maximum daily precipitation with their corresponding F(x), T and y values

RANKING	MAXIMUM DAILY PRECIPITATION (mm)	RANKED MAXIMUM DAILY PRECIPITATION (mm)	F(x)	T	y
1		18	0,024	1,024	-1,318
2	27	23	0,048	1,050	-1,113
3	56,5	23,9	0,071	1,077	-0,970
4	40	25	0,095	1,105	-0,855
5	29	25,3	0,119	1,135	-0,755

RANKING	MAXIMUM DAILY PRECIPITATION (mm)	RANKED MAXIMUM DAILY PRECIPITATION (mm)	F(x)	T	*y*
6	45	25,5	0,143	1,167	-0,666
7	46	27	0,167	1,200	-0,583
8		28	0,190	1,235	-0,506
9		28,5	0,214	1,273	-0,432
10		29	0,238	1,313	-0,361
11		30,7	0,262	1,355	-0,293
12		33	0,286	1,400	-0,225
13		33,3	0,310	1,448	-0,159
14		33,5	0,333	1,500	-0,094
15		34	0,357	1,556	-0,029
16		35	0,381	1,615	0,036
17	23,9	36	0,405	1,680	0,100
18	33,5	37	0,429	1,750	0,166
19	36	37,8	0,452	1,826	0,232
20	46,5	37,9	0,476	1,909	0,298
21	25,5	38,6	0,500	2,000	0,367
22	28	39,3	0,524	2,100	0,436
23	37,8	40	0,548	2,211	0,507
24	61,2	43	0,571	2,333	0,581
25	30,7	43,5	0,595	2,471	0,656
26	25,3	45	0,619	2,625	0,735
27	25	46	0,643	2,800	0,817
28	38,6	46,5	0,667	3,000	0,903
29	37,9	48,2	0,690	3,231	0,993
30	70	51,5	0,714	3,500	1,089
31	35	51,7	0,738	3,818	1,192
32	43,5	51,8	0,762	4,200	1,302
33	23	53,5	0,786	4,667	1,422
34	18	55,8	0,810	5,250	1,554
35	83	56,5	0,833	6,000	1,702
36	33	57	0,857	7,000	1,870
37	51,8	57,5	0,881	8,400	2,066
38	71	61,2	0,905	10,500	2,302
39	37	70	0,929	14,000	2,602
40	57	71	0,952	21,000	3,020
41	53,5	83	0,976	42,000	3,726
42	48,2				

RANKING	MAXIMUM DAILY PRECIPITATION (mm)	RANKED MAXIMUM DAILY PRECIPITATION (mm)	F(x)	T	*y*
43	55,8				
44	57,5				
45	51,5				
46	33,3				
47	39,3				
48	34				
49	28,5				
50	51,7				
51	43				

m_x:	41,756
s_x:	14,579

GUMBEL METHOD	
α:	11,367
u:	35,194

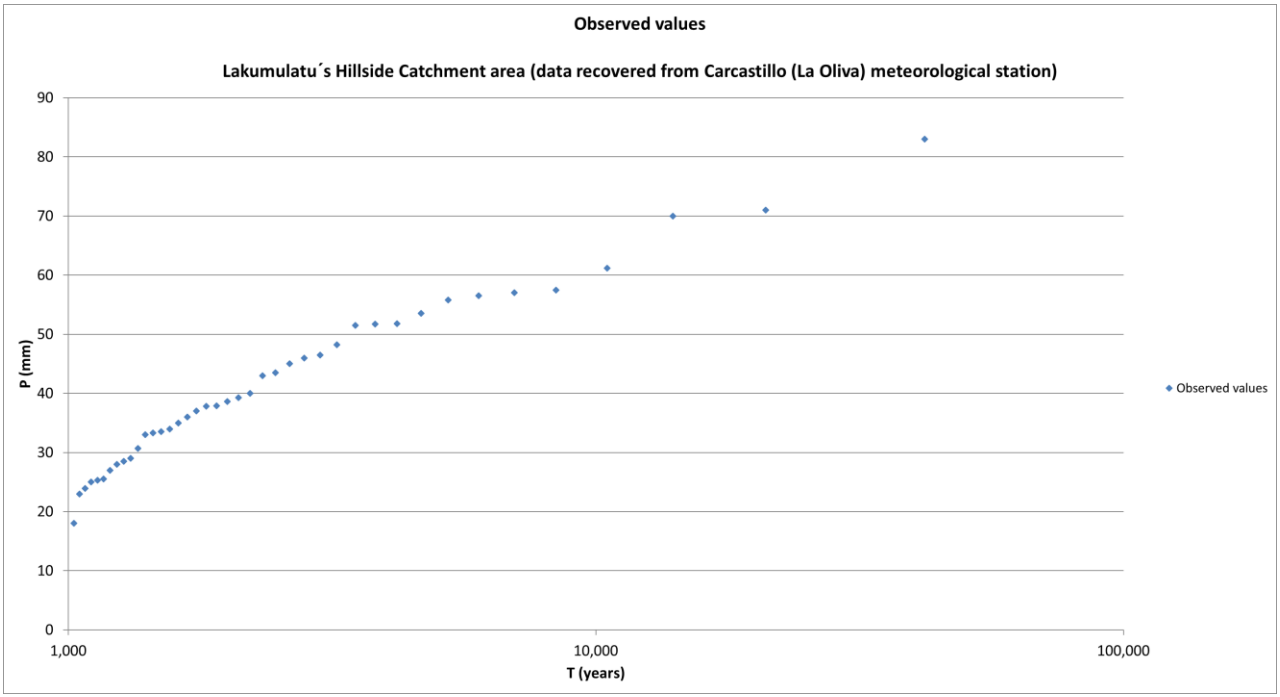


Figure 3: Observed values precipitation curve in the Lakumulatu´s hillside catchment area

Once the 'Observed Values' curve was obtained, in the ninth place, the daily rainfall associated with different return periods (2, 5, 10, 25, 50, 100, 200, 200, 500 and 1000 years) were calculated in the Frequency Analysis. This analysis was carried out through three different models:

- Gumbel distribution function-Parameters Model (Table 5):

Table 5: Parameters Model data and results

Parameters			
T	F(x)	y	x
2	0,500	0,366	39,361
5	0,800	1,499	52,245
10	0,900	2,250	60,776
25	0,960	3,198	71,554
50	0,980	3,901	79,550
100	0,990	4,6003	87,487
200	0,995	5,295	95,395
500	0,998	6,213	105,829
1000	0,999	6,907	113,714

m_x:	41,756
s_y:	14,579

GUMBEL METHOD	
α:	11,367
u:	35,194

Where:

T: It is set in the quantiles: 2, 5, 10, 25, 50, 100, 200, 500 and 1000 years
F(x) = (T-1)/T
$x = y*\alpha+u$

- Gumbel-Frequency factor Model (Table 6):

Table 6: Frequency factor Model data and results

Frequency factor			
T	yt	kt	P
2	0,366	-0,153	39,518
5	1,499	0,825	53,791
10	2,250	1,47	63,241
25	3,198	2,292	75,181
50	3,901	2,900	84,038
100	4,600	3,503	92,831
200	5,295	4,104	101,591
500	6,213	4,896	113,149
1000	6,907	5,495	121,883

m_y:	0,544
s_y:	1,157

Where:

T: It is set in the quantiles: 2, 5, 10, 25, 50, 100, 200, 500 and 1000 years
$y_t = Ln(Ln(T/(T-1)))$
$k_t = (y_t - m_y)/s_y$
$P = m_x + k_t * s_x$
m_y: Mean of y
s_y: Typical deviation of y

- Precipitation map Model (Table 7):

Table 7: Precipitation map Model data and results

Precipitation map		
T	kt	P
2	0,914	41,130
5	1,240	55,800
10	1,469	66,105
25	1,793	80,685
50	2,052	92,340
100	2,327	104,715
200	2,617	117,765
500	3,014	135,630
1000	-	-

From de Ministry map:	
CV:	0,390
Pm:	45

Where:

T: It is set in the quantiles: 2, 5, 10, 25, 50, 100, 200, 500 and 1000 years
k_t: Data obtained from *Map for the Calculation of Maximum Daily Precipitation in Peninsular Spain* (Development Ministry, 1997).
$P = k_t * P_m$
P_m: Data obtained from *Maximum daily rains in peninsular Spain* (Development Ministry, 1999)
CV: Data obtained from *Maximum daily rains in peninsular Spain* (Development Ministry, 1999)

After having calculated the precipitation values (P) associated with a return period for each of the three models, in the tenth place, these were represented in the Figure 4, in a scatter plot together to the previously obtained curve.

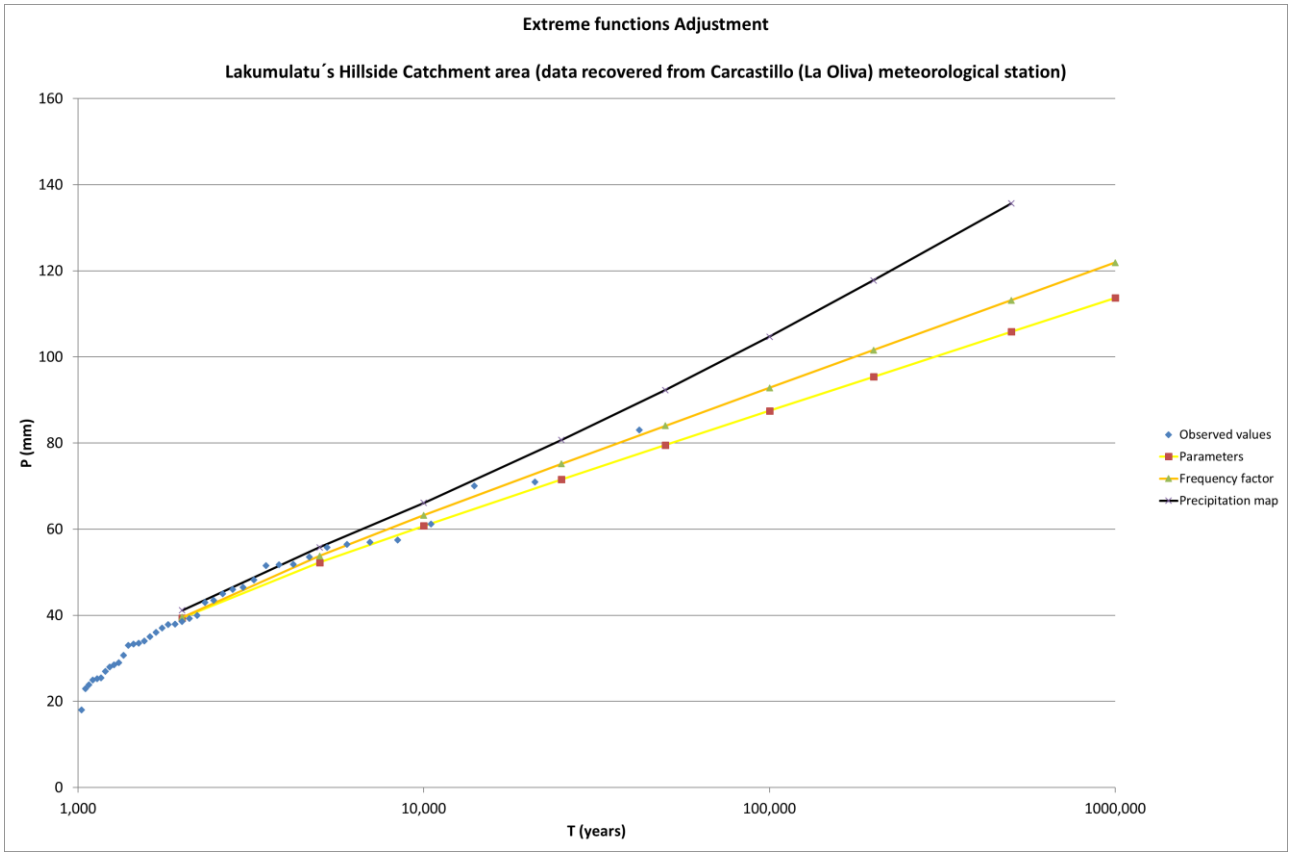


Figure 4: Extreme functions adjustment

As it could be seen in the Figure 4, the model that best fitted the Observed Values curve was the Frequency factor. Consequently, since the Frequency Factor was the model that best fitted the Observed Values, it was the model that was used for the calculation of the flow rate Q.

In the eleventh place, IDF curves (Intensity-Duration-Frequency) were calculated. In order to do that, the concentration time (Tc), the parameter representing the ratio of the hourly intensity to the daily intensity for a return period (I1/Id), the average daily precipitation intensity (Id), and the average intensity for a reference interval($I_{\Delta T}$) were calculated.

- Concentration time Tc (Table 8):

Table 8: Concentration time calculation

BASIN	J (m/m)	L (km)	S (km^2)	Ku	Tc (h)
1	0,08	0,02616	0,00012	1	0,03345
2	0,08	0,01445	0,00005	1	0,02130
3.1	0,08	0,083	0,00251	1	0,08043
3.2	0,08	0,089	0,00258	1	0,08481

BASIN	J (m/m)	L (km)	S (km^2)	Ku	Tc (h)
4	0,08	0,05014	0,00107	1	0,05484
5.1	0,08	0,126	0,00405	1	0,11046
5.2	0,08	0,122	0,00489	1	0,10779
6	0,08	0,05189	0,00043	1	0,05628
7.1	0,08	0,248	0,02495	1	0,18480
7.2	0,08	0,141	0,00723	1	0,12032
8	0,08	0,0144	0,00005	1	0,02125
9	0,08	0,07166	0,00045	1	0,07193
10.1	0,08	0,014	0,00380	1	0,02080
10.2	0,08	0,14	0,00552	1	0,11967
10.3	0,08	0,079	0,00258	1	0,07747
10.4	0,08	0,01063	0,00004	1	0,01687
11	0,08	0,04894	0,00023	1	0,05384
12	0,08	0,0425	0,00022	1	0,04836
13	0,08	0,03052	0,00013	1	0,03760
14	0,08	0,00856	0,00002	1	0,01431
15	0,08	0,05013	0,00110	1	0,05483
16	0,08	0,34493	0,01694	1	0,23747
17	0,08	0,02614	0,00012	1	0,03343
18	0,08	0,0094	0,00002	1	0,01536
19	0,08	0,04088	0,00116	1	0,04695
20.1	0,08	0,11324	0,00672	1	0,10185
20.2	0,08	0,03	0,00068	1	0,03711
21	0,08	0,0215	0,00008	1	0,02881
22	0,08	0,01541	0,00006	1	0,02237
23.1	0,08	0,20502	0,00522	1	0,15992
23.2	0,08	0,32015	0,01689	1	0,22439
23.3	0,08	0,37375	0,02272	1	0,25240
24	0,08	0,01928	0,00007	1	0,02652
25	0,08	0,01478	0,00005	1	0,02167
26	0,08	0,01027	0,00004	1	0,01643
27	0,08	0,0946	0,00047	1	0,08884
28	0,08	0,0347	0,00016	1	0,04146
29	0,08	0,02404	0,00010	1	0,03136
30	0,08	0,01502	0,00007	1	0,02194
31	0,08	0,02801	0,00012	1	0,03523
32	0,08	0,00925	0,00002	1	0,01518
33	0,08	0,04282	0,00023	1	0,04864

Where:

$Tc = 0,33 * Ku * (L/J^{1/4})^{0,76}$; (h)

L: Length of the main channel (longest) ; (km)
J: Average slope of the main channel ; (m/m)
Ku: Urbanization coefficient (1 in rural areas)
P_0: Initial loss coefficients. Obtained from the Rule 5.2-IC Surface Drainage of the Road Instruction.

- Parameter representing the ratio of the hourly intensity to the daily intensity for a return period (I1/Id):

  The I1/Id parameter depends primarily on the zone. This was obtained from the map presented in the Rule 5.2-IC Surface Drainage of the Road Instruction. In the case of Ujué, parameter I1/Id took a value of 10

- Average daily intensity of precipitation (Id) (Table 9):

Table 9: Precipitation average daily intensity with their corresponding return period

T:	Pt:	Id:
2	39,518	1,646
5	53,791	2,241
10	63,241	2,635
25	75,181	3,132
50	84,038	3,501
100	92,831	3,867
200	101,591	4,232
500	113,149	4,714
1000	121,883	5,078

Where:

Id = Pt/24 ; (mm/h)

- Average intensity for a reference interval ($I_{\Delta T}$) (Table 10):

Table 10: Concentration time for the different return periods

Δt (h)	$I_{\Delta T=2}$	$I_{\Delta T=5}$	$I_{\Delta T=10}$	$I_{\Delta T=25}$	$I_{\Delta T=50}$	$I_{\Delta T=100}$	$I_{\Delta T=200}$	$I_{\Delta T=500}$	$I_{\Delta T=1000}$
0,1667	42,7963	58,2530	68,4867	81,4169	91,0094	100,5309	110,0178	122,5339	131,9932
0,3333	30,1775	41,0767	48,2929	57,4105	64,1746	70,8886	77,5782	86,4038	93,0740
0,5	24,3182	33,1012	38,9163	46,2637	51,7144	57,1248	62,5156	69,6276	75,0027
1	16,4661	22,4131	26,3505	31,3255	35,0162	38,6797	42,3298	47,1454	50,7850
2	10,8416	14,7573	17,3498	20,6254	23,0555	25,4676	27,8709	31,0416	33,4379
3	8,3742	11,3988	13,4012	15,9314	17,8084	19,6716	21,5279	23,9770	25,8280
6	5,2526	7,1497	8,4057	9,9927	11,1700	12,3386	13,5030	15,0392	16,2001
9	3,9373	5,3594	6,3009	7,4905	8,3730	9,2490	10,1218	11,2733	12,1436

Δt (h)	$I_{\Delta T=2}$	$I_{\Delta T=5}$	$I_{\Delta T=10}$	$I_{\Delta T=25}$	$I_{\Delta T=50}$	$I_{\Delta T=100}$	$I_{\Delta T=200}$	$I_{\Delta T=500}$	$I_{\Delta T=1000}$
12	3,1861	4,3368	5,0987	6,0614	6,7755	7,4844	8,1907	9,1225	9,8267
18	2,3394	3,1843	3,7437	4,4506	4,9749	5,4954	6,0140	6,6982	7,2153
24	1,8645	2,5379	2,9838	3,5471	3,9650	4,3799	4,7932	5,3385	5,7506
2,0898	10,5479	14,3575	16,8797	20,0666	22,4309	24,7776	27,1158	30,2006	32,5321

Where:

$I_{\Delta T} = Id * (I1/Id)^{(28^{0,1}-\Delta t^{0.1})/(28^{0,1}-1)}$; (mm/h)

Δt: duration of the rain intensity reference interval (h) (the following reference intervals are used: 0,16, 0,33, 0,5, 1, 2, 3, 6, 9, 12, 18 and 24 hours, in addition to Tc value)

Once the medium intensity data are known, the IDF curves were plotted Figure 5:

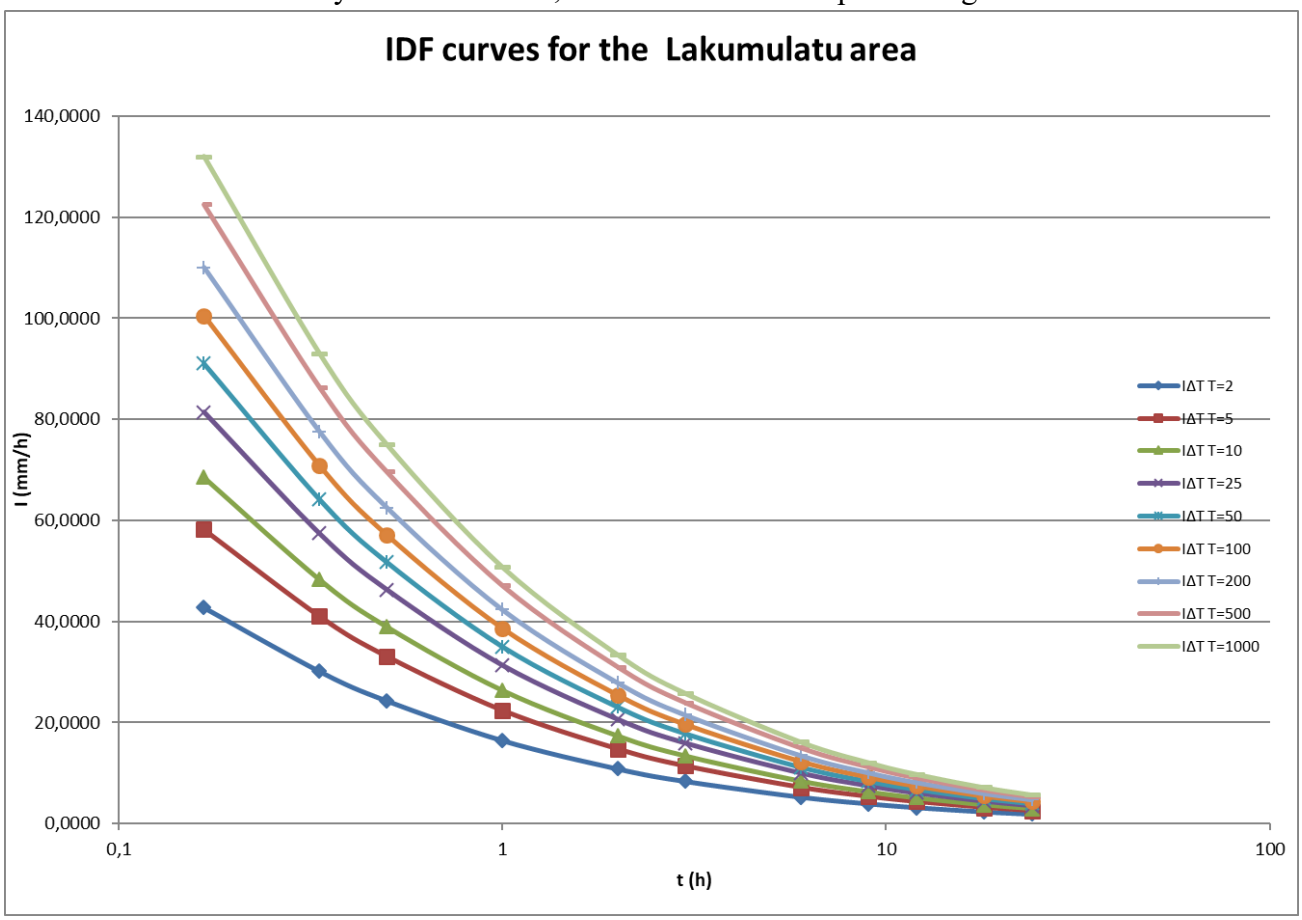


Figure 5: IDF curves for the different return periods

In the twelfth place, the maximum flow rate of the basin (Q) associated with a return period produced by precipitation of uniform intensity throughout the catchment area was calculated assuming a constant runoff coefficient for the entire basin. This will require the runoff coefficient (C), the intensity of the rain for a duration of concentration time (I) and the surface of the basin (A). For this project, and as it is established in the Rule 5.2-IC Surface Drainage of the Road Instruction, a return period of 25 years was selected.

- Runoff coefficient (C):

  Where:

  $C = ((Pd/P_0 -1) * (Pd/P_0 +23))/(Pd/P_0 +11)^2$

- Flow rate (Q):

  Where:

  $Q = (C*I*A)/3,6$; (m^3/s)

Therefore, the values of the flow rates produced after precipitation with a return period of 25 years are the ones showed below. However, as flow rate sizing is usually intended for the sizing of hydraulic structures and drainage structures, those values were magnified using. a safety coefficient K of 20% in order to be on the safety side thus considering the possible precipitation tips (Table 11).

Table 11: Lakumulatu´s hillside basins flow rates

BASIN	T (years)	Pd (mm)	C	I (mm/h)	A (km^2)	Q (m^3/s)	K	Q´ (m^3/s)
1	25	75,1813	0,6953	20,0666	0,00012	0,00046	0,2	0,00056
2	25	75,1813	0,6953	20,0666	0,00005	0,00018	0,2	0,00022
3.1	25	75,1813	0,6953	20,0666	0,00251	0,00972	0,2	0,01166
3.2	25	75,1813	0,6953	20,0666	0,00258	0,01001	0,2	0,01202
4	25	75,1813	0,6953	20,0666	0,00107	0,00415	0,2	0,00498
5.1	25	75,1813	0,6953	20,0666	0,00405	0,01570	0,2	0,01885
5.2	25	75,1813	0,6953	20,0666	0,00489	0,01895	0,2	0,02274
6	25	75,1813	0,6953	20,0666	0,00043	0,00165	0,2	0,00199
7.1	25	75,1813	0,6953	20,0666	0,02495	0,09669	0,2	0,11603
7.2	25	75,1813	0,6953	20,0666	0,00723	0,02802	0,2	0,03363
8	25	75,1813	0,6953	20,0666	0,00005	0,00018	0,2	0,00021
9	25	75,1813	0,6953	20,0666	0,00045	0,00174	0,2	0,00209
10.1	25	75,1813	0,6953	20,0666	0,00380	0,01472	0,2	0,01767
10.2	25	75,1813	0,6953	20,0666	0,00552	0,02141	0,2	0,02569
10.3	25	75,1813	0,6953	20,0666	0,00258	0,00998	0,2	0,01198
10.4	25	75,1813	0,6953	20,0666	0,00004	0,00017	0,2	0,00020
11	25	75,1813	0,6953	20,0666	0,00023	0,00088	0,2	0,00106
12	25	75,1813	0,6953	20,0666	0,00022	0,00086	0,2	0,00104
13	25	75,1813	0,6953	20,0666	0,00013	0,00049	0,2	0,00059
14	25	75,1813	0,6953	20,0666	0,00002	0,00008	0,2	0,00010
15	25	75,1813	0,6953	20,0666	0,00110	0,00427	0,2	0,00513

BASIN	T (years)	Pd (mm)	C	I (mm/h)	A (km^2)	Q (m^3/s)	K	Q´ (m^3/s)
16	25	75,1813	0,6953	20,0666	0,01694	0,06567	0,2	0,07880
17	25	75,1813	0,6953	20,0666	0,00012	0,00047	0,2	0,00056
18	25	75,1813	0,6953	20,0666	0,00002	0,00009	0,2	0,00010
19	25	75,1813	0,6953	20,0666	0,00116	0,00451	0,2	0,00542
20.1	25	75,1813	0,6953	20,0666	0,00672	0,02603	0,2	0,03124
20.2	25	75,1813	0,6953	20,0666	0,00068	0,00264	0,2	0,00317
21	25	75,1813	0,6953	20,0666	0,00008	0,00030	0,2	0,00036
22	25	75,1813	0,6953	20,0666	0,00006	0,00024	0,2	0,00028
23.1	25	75,1813	0,6953	20,0666	0,00522	0,02024	0,2	0,02429
23.2	25	75,1813	0,6953	20,0666	0,01689	0,06546	0,2	0,07856
23.3	25	75,1813	0,6953	20,0666	0,02272	0,08807	0,2	0,10569
24	25	75,1813	0,6953	20,0666	0,00007	0,00026	0,2	0,00032
25	25	75,1813	0,6953	20,0666	0,00005	0,00018	0,2	0,00021
26	25	75,1813	0,6953	20,0666	0,00004	0,00015	0,2	0,00017
27	25	75,1813	0,6953	20,0666	0,00047	0,00182	0,2	0,00218
28	25	75,1813	0,6953	20,0666	0,00016	0,00064	0,2	0,00076
29	25	75,1813	0,6953	20,0666	0,00010	0,00039	0,2	0,00047
30	25	75,1813	0,6953	20,0666	0,00007	0,00029	0,2	0,00035
31	25	75,1813	0,6953	20,0666	0,00012	0,00048	0,2	0,00058
32	25	75,1813	0,6953	20,0666	0,00002	0,00009	0,2	0,00011
33	25	75,1813	0,6953	20,0666	0,00023	0,00087	0,2	0,00105

However, the basins are not independent one of each other. As it can be seen in the Plan Nº 7.1, there are basins whose discharge point pour the water into another basin. That is the reason why, before carrying out the Hydraulic testing of the drainage elements, the value of the corrected flow rates are added according to the aforementioned criteria (Table 12).

Table 12: Flow rate accumulation

BASIN	DISCHARGES IN…	Q´ (m^3/s)	Q total (m^3/s)
1	-	0,00056	0,00056
2	-	0,00022	0,00022
3.1	-	0,01166	0,01166
3.2	-	0,01202	0,03475
4	-	0,00498	0,00498
5.1	-	0,01885	0,01906
5.2	3.2	0,02274	0,02274
6	-	0,00199	0,00199
7.1	-	0,11603	0,40060
7.2	-	0,03363	0,02838
8	5.1	0,00021	0,00021

BASIN	DISCHARGES IN…	Q´ (m^3/s)	Q total (m^3/s)
9	-	0,00209	0,00209
10.1	-	0,01767	0,01823
10.2	7.2	0,02569	0,02569
10.3	7.1	0,01198	0,01218
10.4	10.3	0,00020	0,00020
11	7.2	0,00106	0,00106
12	7.2	0,00104	0,00104
13	7.2	0,00059	0,00059
14	7.1	0,00010	0,00010
15	7.1	0,00513	0,00513
16	7.1	0,07880	0,18829
17	10.1	0,00056	0,00056
18	-	0,00010	0,00010
19	-	0,00542	0,00542
20.1	-	0,03124	0,03124
20.2	16	0,00317	0,00317
21	16	0,00036	0,00036
22	16	0,00028	0,00028
23.1	-	0,02429	0,02429
23.2	7.1	0,07856	0,07856
23.3	16	0,10569	0,10569
24	7.1	0,00032	0,00032
25	-	0,00021	0,00021
26	-	0,00017	0,00017
27	-	0,00218	0,00218
28	-	0,00076	0,00076
29	-	0,00047	0,00047
30	-	0,00035	0,00035
31	-	0,00058	0,00058
32	-	0,00011	0,00011
33	-	0,00105	0,00105

3. HYDRAULIC CHECKING OF THE DRAINAGE ELEMENTS

Once the real flow rates that will affect to each one of the different basins were calculated, a hydraulic checking of all the drainage elements was carried out. For those testing the Manning equation was used:

$Q = 1/n * R^{2/3} * A * I^{1/2}$

Where:

Q: Flow rate ; (m^3/s)
R: Hydraulic radius = A/P ; (m^2/m)
A: Wetted cross section area ; (m^2)
P: Wetted perimeter ; (m)
I: Slope of the energy line ; (m/m)
n: Coefficient of roughness ; ($s/m^{1/3}$)

In the case of the gutters the calculations were carried out supposing that the water flows at a depth equal to 2/3 of the total one. For that case the following data was considered:

R: 0,1324 m^2/m
A: 0,155 m^2
P: 1,17 m
I: 0,08 m/m
n: 0,025 $s/m^{1/3}$

Consequently, the following flow rate value was obtained:

$Q = 1/0,025 * 0,1324^{2/3} * 0,155 * 0,08^{1/2} = 0,4557\ m^3/s$

As it could be checked, there is not any basin that has a flow rate value above the calculated one. That is the reason why all the gutters are considered enough for this purpose.

In the case of the a reinforced concrete 400mm diameter pipe the calculations were carried out supposing that the water flows at a depth equal to 2/3 of the total one. For that case the following data was considered:

R: 0,1184 m^2/m
A: 0,09 m^2
P: 0,76 m
I: 0,02 m/m (minimum slope in order to ensure the drainage)
n: 0,013 $s/m^{1/3}$

Consequently, the following flow rate value was obtained:

$Q = 1/0,013 * 0,1184^{2/3} * 0,09 * 0,02^{1/2} = 0,2361\ m^3/s$

As it could be checked, there is not any transversal drainage pipe that has a flow rate value above the calculated ones, since only the basins 3.2, 5, 5.2, 6, 7.2, 10.2, 10.3, 15, 19, 20.2, 23.1, 23.2 and 23.3 need this system. That is the reason why all the drainage concrete pipes are considered enough for this purpose. Although from a hydraulic point of view a smaller diameter pipe could have been

installed, this option was not considered since the 400 mm pipe is the smallest diameter with which cleaning tasks can be carried out easily.

4. REFERENCES

Development Ministry. (1997). *Map for the Calculation of Maximum Daily Precipitation in Peninsular Spain.* Madrid: Development Ministry.

Development Ministry. (1999). *Maximum daily rains in peninsular Spain.* Madrid: Development Ministry.

Roads General Directorate. (1987). *Hydrometeorological calculation of maximum flows in small natural basins.* Madrid: MOPU.

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Appendix Nº4: Expropriations

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

The aim of this appendix is to determine the affected plots and services and to accomplish the specific assessment for each of those cases in order to carry out the corresponding expropriations.

2. AFFECTED PLOTS

The final occupancy area includes the services and land necessary to carry out the project execution, as it can be checked in the Plan Nº8. The Table 13 shows the different plots that will be affected by the execution of the present country road:

Table 13: Affected plots

	Agricultural Plot	Agricultural estate	Affected surface (m^2)	Use	Class
Expropriation 1	191	18	34040,9091	Forest rangeland	3
Expropriation 2	252	18	1779,2486	Forest rangeland	3
Expropriation 3	227	18	2478,0241	Forest rangeland	3
Expropriation 4	140	18	1735,5609	Forest rangeland	3

As far as the affected lands to expropriate are concerned, all of them are Forest rangeland. The payment of a fair price for the expropriated area is proposed but the possibility of swaps is not excluded.

3. AFFECTED AREA ASSESMENT

3.1. ASSESMENT CRITERIA

The value of the land will be determined by comparison of similar plots method. For these purposes, the identity of reason that justifies the analogy must take into account the urban regime, the situation, size and nature of the aforementioned plots in relation to the one being assessed, as well as the uses that are susceptible.

The Foral Decree 39/2015, of June 17th, approves the assessment procedure of certain real estate located in the Autonomous Community by applying the method of checking average prices in the

market, in relation to the management of taxes on inheritance and donations, and on property transfers and documented legal acts.

The land assessment based on the Foral Decree 39/2015, of June 17th, covers a statistical population of sufficient dimension to be able to provide objective and neutral data on market values of the land. Therefore, the valuation is considered adequate, in accordance with the Foral Decree 39/205, of June 17th .

The Unit Reference Value set according to Foral Decree 39/2015, of June 17th, for class Nº3 Forest rangelands rustic soils located in Ujué is 144,24 €/ha.

3.2.EXPROPRIATIONS COMPENSATORY PAYMENT

The value corresponding to the compensatory payment for each plot is presented in the Table 14. The total cost of the expropriations that will be carried out in order to carry out this project will be 577,45 €.

Table 14: Affected plots assessment

	Agricultural Plot	Agricultural estate	Affected surface (m^2)	Use	Class	Assessment (€)
Expropriation 1	191	18	34040,9091	Forest rangeland	3	491,0060
Expropriation 2	252	18	1779,2486	Forest rangeland	3	25,6638
Expropriation 3	227	18	2478,0241	Forest rangeland	3	35,7430
Expropriation 4	140	18	1735,5609	Forest rangeland	3	25,0337

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Appendix Nº5: Price Justification

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

The aim of this appendix is to justify the prices calculation which has been adopted in the present project considering the Navarra´s forest fees price database provided by Gobierno de Navarra.

The prices preparation has been carried out through the following process:

- Structuring the price base in chapters, subchapters and articles.
- Decomposed prices: all the prices necessary for the formation of the work units used in the preparation of country road budgets are included.
- Work units: this price database includes the units that will be used in future budgeting.

2. PRICE JUSTIFICATION

The price calculation of the different work units will be based on the direct and indirect costs determination, as indicated in Royal Decree 1098/2001 of October 12th, required for its execution, without incorporating, in any case, the amount of the Value Added Tax (IVA) that may be levied on deliveries of goods or services rendered.

In the development of the work units, on the one hand, the direct costs of the concepts included in the price breakdown of the following groups:

- Labor: The price of labor has been calculated based on the base salary established in the Collective Labor Agreement of the Navarra´s Agricultural sector, whose functional scope also includes forest companies in Navarra. To the updated salary cost of each professional category, the cost of social security, the cost of subsistence and travel expenses and additional costs have been added.
- Machinery: Due to the disparity in the hourly machinery prices provided by the contractors, once they have been contrasted with the prices used in the rates of TRAGSA and checked the coincidence between them, it has been decided to use that database in most cases.
- Materials: Whenever possible, the prices indicated in the commercial catalogs of the companies or provided by them have been used in response to requests for information about their rates, in any case, companies that work in Navarra. These rates can be checked in the Appendix III of the aforementioned price database.

On the other hand, the indirect costs incidence, derived from the support structure for carrying out the works, has been taken into account. They have been included in the price database as percentages to be applied to the cost of work unit. Its value will depend on the type of work, being 1% for repopulation and forestry work and 2,5% for those works related to infrastructures.

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Appendix Nº6: Waste Management Plan

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

The aim of this appendix will be to study the waste management that will be needed to carry out during the execution of this project as indicated in the Royal Decree 105/2008 of February 1st, in which the production and management of construction and demolition waste are regulated.

2. WASTE IDENTIFICATION

For this purpose, two categories of Construction and Demolition Waste (RCD) can be identified:

- Level I RCDs: Waste generated by the development of infrastructure works at the local or supra-municipal level contained in the different urban action plans or regional development plans, resulting from surplus excavation of the generated earthworks. in the course of these works. It is, therefore, the uncontaminated stone materials and soils from excavation and cleaning works.
- Level II RCDs.- Waste generated, mainly, from activities in the construction, demolition, repairs and service implementation sectors. They are non-hazardous wastes that do not undergo significant physical, chemical or biological transformation

Inert wastes are not soluble nor combustible, they do not react physically or chemically or in any other way, are not biodegradable and they do not negatively affect other materials with which they come into contact in a way that could lead to contamination of the environment or harm human health. Inert waste from construction and demolition works, including minor construction and repair works subject to municipal license or not, is contemplated.

The waste generated will be only those of the Waste European List marked below (Table 15). Materials that do not exceed $1m^3$ of supply and are not considered dangerous (and therefore require special treatment) will not be included in the general calculation.

Table 15: Generated wastes description

Code	Waste description
Level I RCDs	
17 05 04	Soil and stones other than those mentioned in 17 05 03
Level II RCDs	
17 02 01	Wood

3. ESTIMATION OF THE WASTES TO BE GENERATED

The estimation (Table 16) will be made based on the categories showed in the previous point.

Table 16: Generated wastes estimation

Code	Waste description	Estimation (m^3)
Level I RCDs		
17 05 04	Soil and stones other than those mentioned in 17 05 03	8000
Level II RCDs		
17 02 01	Wood	5

4. IN-SITU SEGREGATION MEASURES

Based on Article 5.5 of RD 105/2008, construction and demolition waste must be separated into fractions when, individually for each of these fractions, the expected amount of generation for the total work exceeds the following amounts (Table 17):

Table 17: Waste-amount limits by types of wastes indicated in the Article 5.5 of RD 105/2008

Concrete	80 t
Bricks, tiles, ceramics	40 t
Metals	2 t
Wood	1 t
Glass	1 t
Plastics	0,5 t
Paper and cardboard	0,5 t

Consequently, the following measures will be carried out for those types of wastes:

- Complete demolition or collection of new construction debris "all mixed", and subsequent treatment at the plant.

As far as the soil and stones from the excavations are concerned, based on Article 3.1 of RD 105/2008, they fall outside the application scope of the aforementioned Royal Decree. Consequently, these will not be considered as wastes but will be transported to an authorized landfill

5. REUSE OPERATIONS FORECAST

As far as the reuse operations are concerned, the land reuse from excavation is predicted to be used on-site. However, with those materials that either cannot be used on site or that simply remain, they will be transported to an authorized landfill.

6. VALUATION OPERATIONS FORECAST

As far as the valuation operations are concerned, those materials that will not be reused on site or in external locations will be transported to an authorized landfill.

7. FACILITIES PLANS

No facilities are foreseen for the storage, handling, separation and, where appropriate, other operations for the management of construction and demolition waste on the site, since they will be removed directly from the work itself to the landfill.

8. COST ASSESMENT

The cost of the correct management of construction and demolition waste is considered in the Chapter 5 of the Document Nº6: Budget of this project, amounting to 36075,15 €.

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Appendix Nº7: Graphic Appendix

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

The aim of this appendix will be to show through different photographs (taken with Nikon D3300 with a AF-S DX Nikkor 35mm f/1.8G lens on March 14th, 2020, for the Lakumulatu´s area and on May 27th, 2020, for the Murillo el Fruto I country road area) and a 3D reconstruction model (generated with MDT 7) both the area where the designed country road will be settled and how the modified terrain will look.

2. PHOTOGRAPHS

Picture 1: Lakumulatu´s hillside seen from the agricultural plot Nº245 of the agricultural estate Nº18 in Ujué (Navarra)

Picture 2: Almond orchard placed in the agricultural plot Nº140 of the agricultural state Nº18 in Lakumulatu area in Ujué (Navarra)

Picture 3: Cereal plantation in the agricultural plot Nº18 of the agricultural estate Nº18 in Lakumulatu area in Ujué (Navarra). Ujue´s village can be seen in the background of this picture.

Picture 4: Lakumulatu´s area country road close to the attachment area

Picture 5: Attachment area of the designed country road with the one of Lakumulatu´s area next to the agricultural plot Nº140Q of the agricultural estate Nº18 in Ujué (Navarra). Lakumulatu´s hillside can be seen in the background.

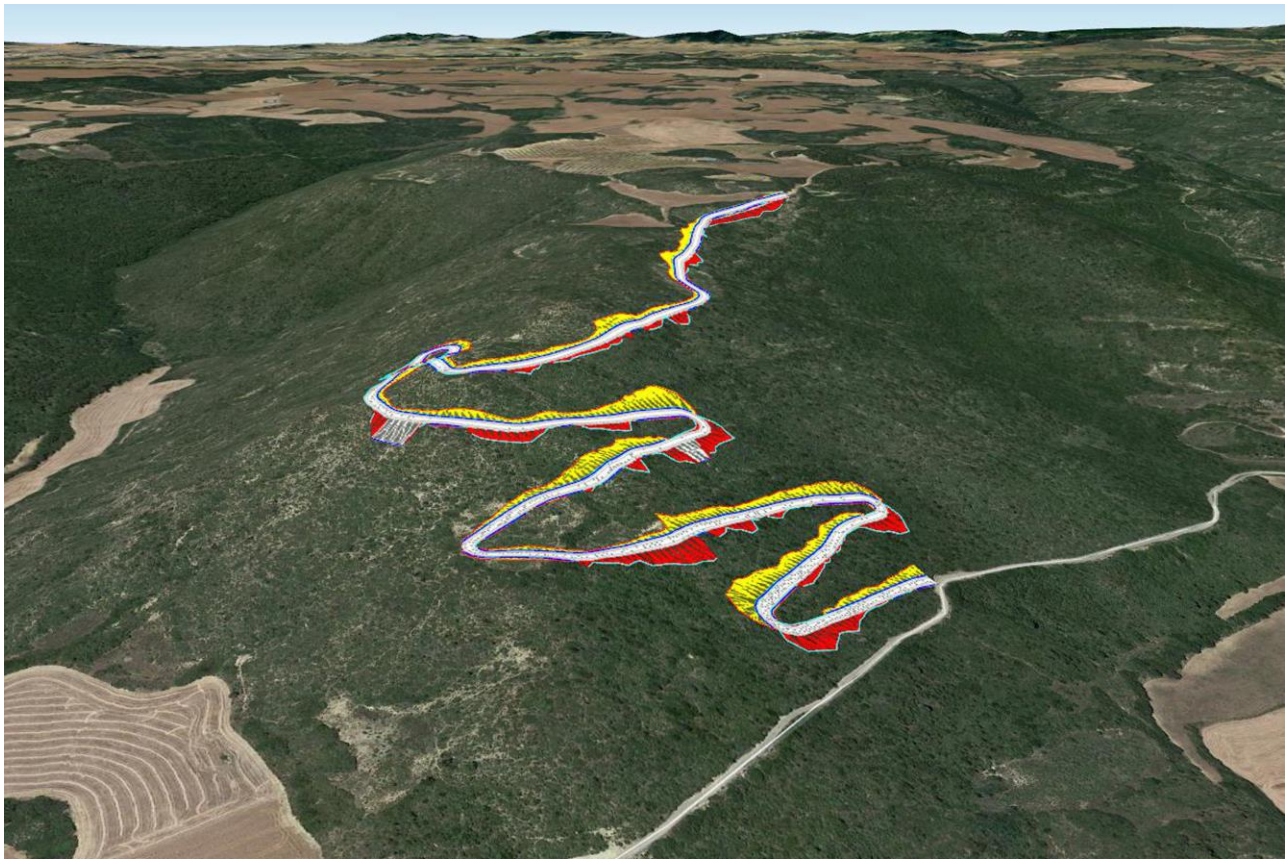
Picture 6: Cereal plantation in the Lakumulatu´s gorge next to Murillo el Fruto I country road

Picture 7: Murillo el Fruto I country road. The Lakumulatu´s hillside can be seen on the right side of the picture

Picture 8: Lakumulatu´s hillside seen from Murillo el Fruto I country road close to the attachment area

Picture 9: Attachment area of the designed country road with the Murillo el Fruto I country road. Lakumulatu´s hillside can be seen in the background.

3. RECONSTRUCTION MODEL



Picture 10: 3D reconstruction model of the designed country road in the Lakumulatu´s hillside generated with MDT 7

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº3: Plans

presentado por

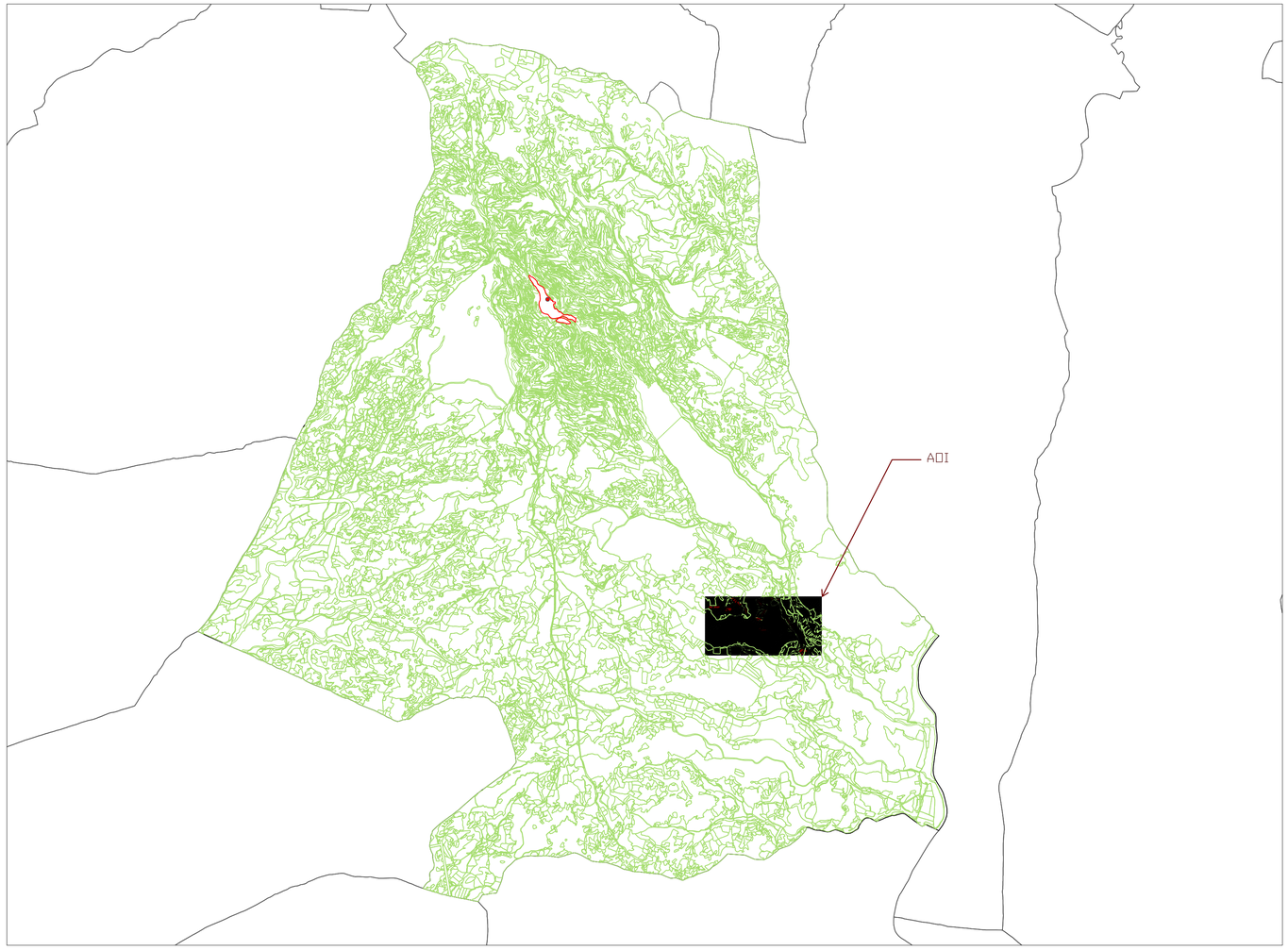
Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

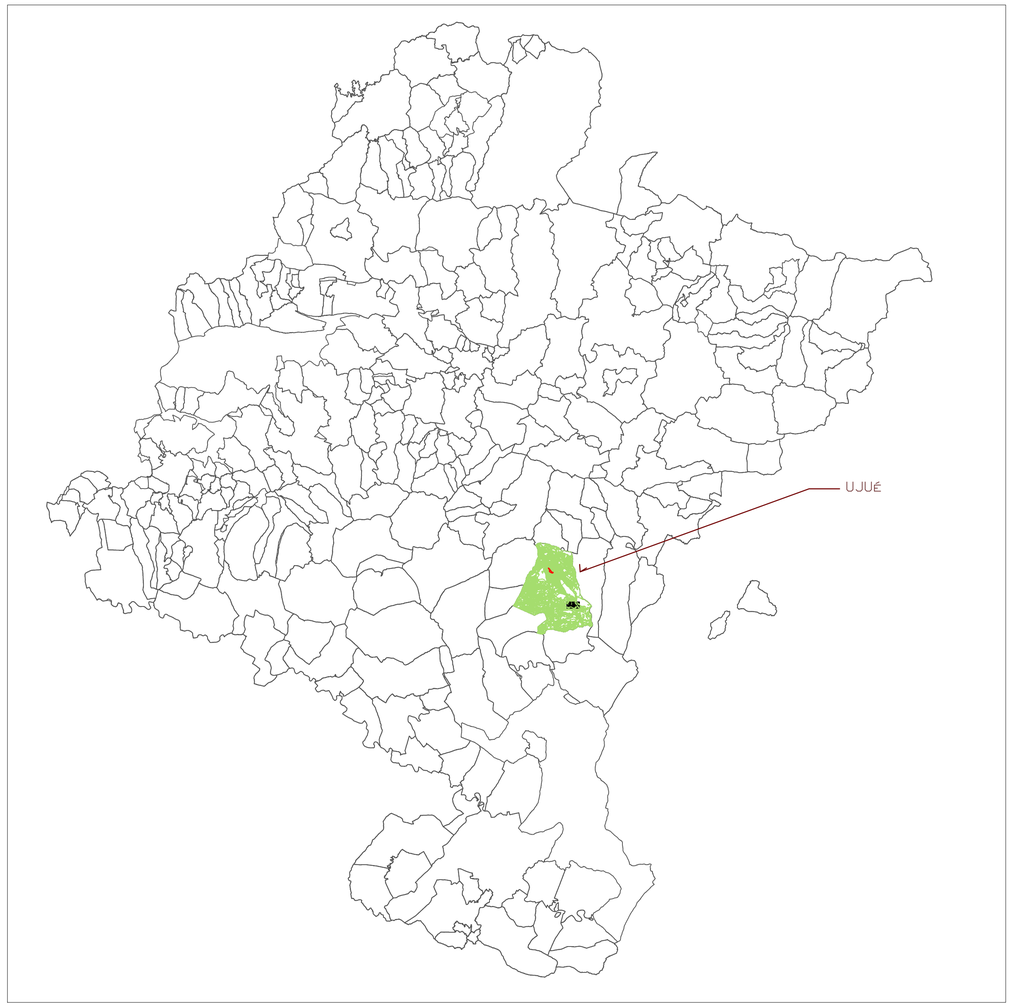
Junio, 2020 / *2020ko ekaina*

INDEX



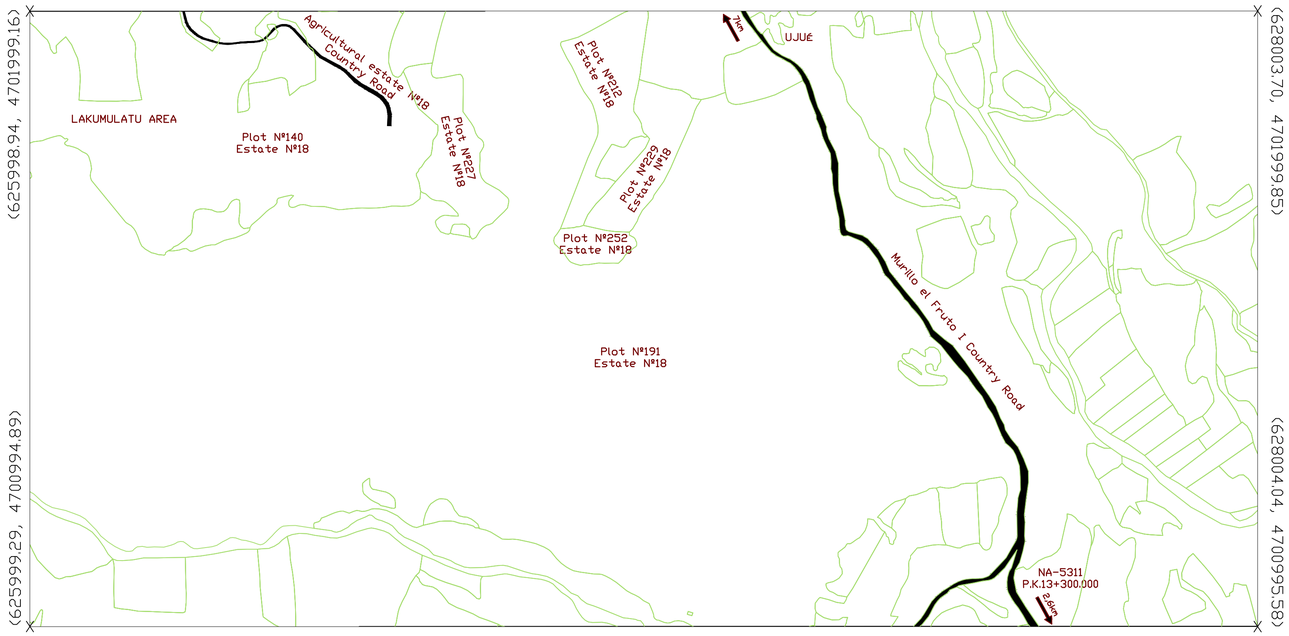
UJUÉ

SCALE: 1/50000



NAVARRA

SCALE: 1/500000



AOI

SCALE: 1/5000

LEGEND

- Boundaries
- Land registry
- Ujue's urban core
- Pre-existing country roads

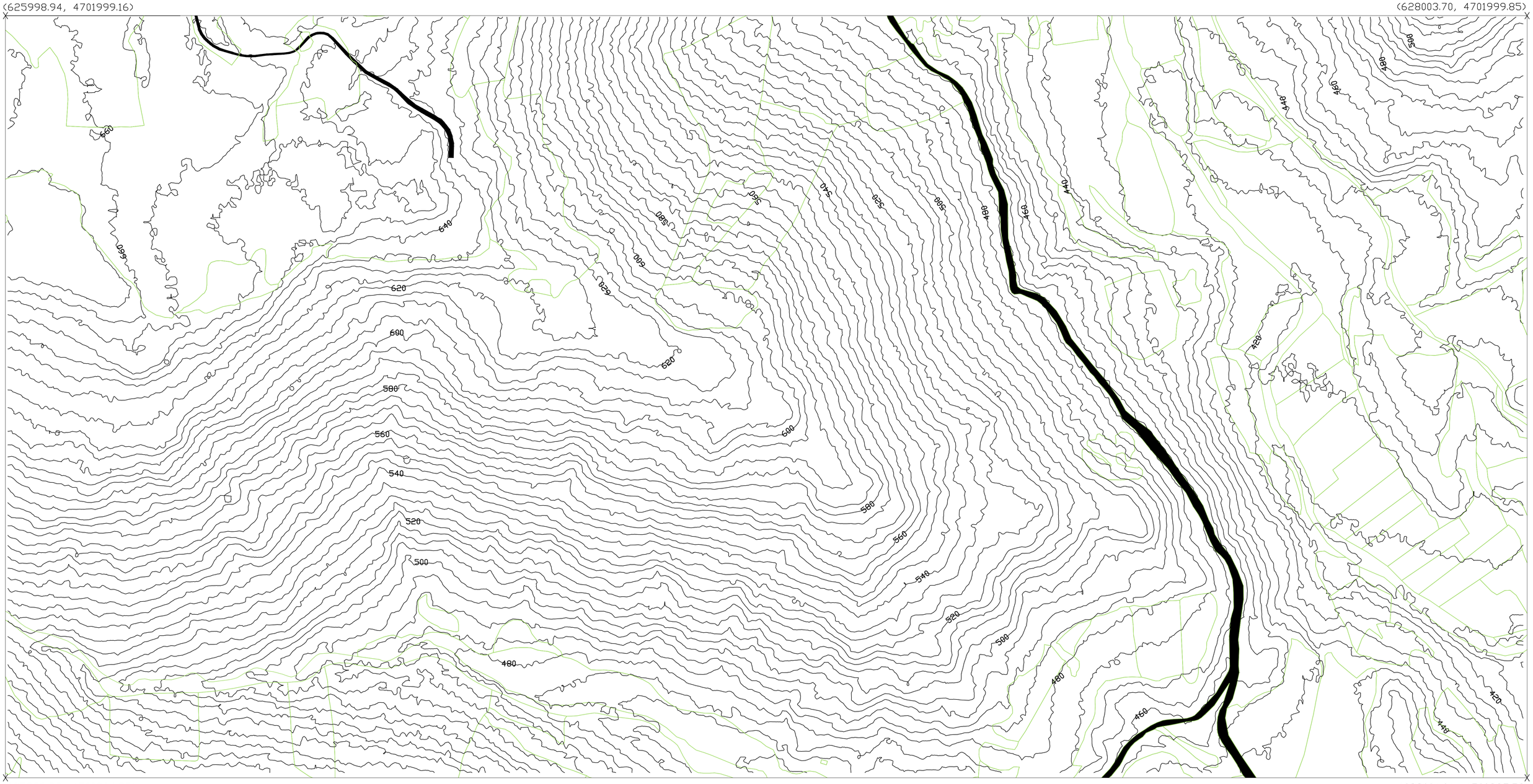
upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_1	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Location and emplacement plan	
Technical reference: Asier Gamallo Valls Approved by: Asier Gamallo Valls	Edited (1st time): 21/03/2020 Edited (present): 27/03/2020	SCALE: SEVERAL Plan number: 1

(625998.94, 4701999.16)

(628003.70, 4701999.85)



(625999.29, 4700994.89)

(628004.04, 4700995.58)

LEGEND

- Contours
- Land registry
- Pre-existing country roads

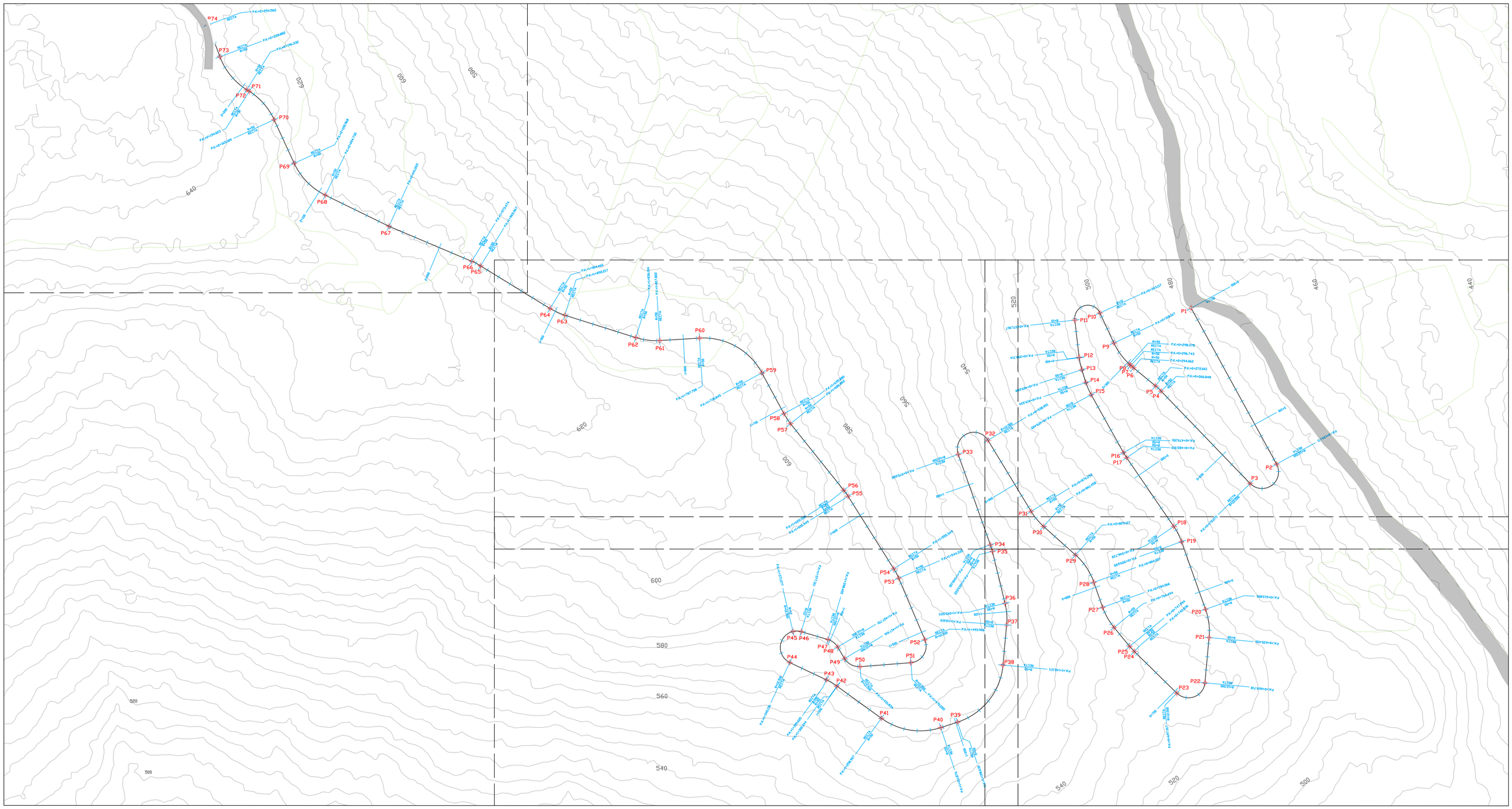
upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_2	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Current state plan	
Technical reference: Asier Gamallo Valls Approved by: Asier Gamallo Valls	Edited (1st time): 21/03/2020 Edited (present): 27/03/2020	SCALE: 1/2500 — Plan number: 2

C B A

I II III



LEGEND

———	Axis
———	Dimensioning
———	Contour lines
———	Land registry
▬▬	Pre-existing country roads
⊕	Beacon points

upna

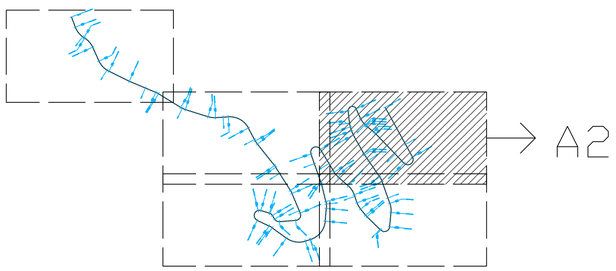
College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_3	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road axis. Master Plan	
Technical reference: Asier Gamallo Valls Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 27/03/2020	SCALE: 1/1500 Plan number: 3

POINT(⊕)	EASTING (X)	NORTHING (Y)
P1	627327.57	4701632.20
P2	627392.01	4701514.57
P3	627372.05	4701499.90
P4	627304.92	4701569.61
P5	627300.65	4701573.55
P6	627284.12	4701587.14
P7	627282.10	4701588.90
P8	627280.89	4701590.00
P9	627269.29	4701605.87
P10	627258.81	4701628.51
P11	627239.80	4701623.15
P12	627243.11	4701595.00
P13	627245.12	4701585.67
P14	627248.17	4701576.08
P15	627252.15	4701566.88
P16	627276.52	4701523.25
P17	627278.93	4701519.37
P18	627314.43	4701467.54
P19	627320.30	4701456.03
P30	627216.27	4701467.59
P31	627206.85	4701478.93
P32	627174.35	4701532.55
P34	627176.15	4701453.65

LEGEND

- Axis
- Dimensioning
- Contour lines
- Land registry
- Pre-existing country roads
- Beacon points



upna

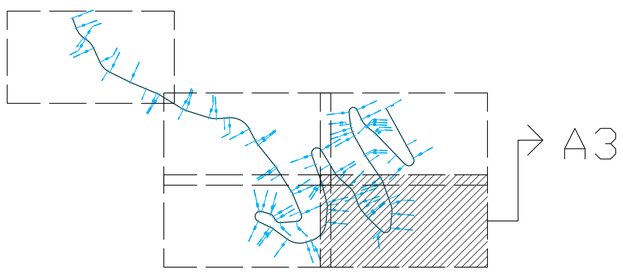
College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_3.1	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road axis. AII area plan	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020
SCALE: 1/500	Plan number: 3.1	

POINT (⊕)	EASTING (X)	NORTHING (Y)
P18	627314.43	4701467.54
P19	627320.30	4701456.03
P20	627338.42	4701405.05
P21	627341.11	4701383.74
P22	627337.98	4701349.61
P23	627316.77	4701341.83
P24	627284.73	4701373.31
P25	627281.24	4701377.11
P26	627269.45	4701391.36
P27	627260.83	4701406.57
P28	627254.17	4701425.42
P29	627240.37	4701446.01
P30	627216.27	4701467.59
P34	627176.15	4701453.65
P35	627177.62	4701448.75
P36	627187.17	4701409.59
P37	627188.40	4701393.24
P38	627185.65	4701362.99

LEGEND

- Axis
- Dimensioning
- Contour lines
- Land registry
- Pre-existing country roads
- Beacon points



upna	College of Agricultural Engineering and Biosciences Agricultural and Rural Environment Engineering Degree FINAL PROJECT		
PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_3.2		Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)		
Project maker: Asier Gamallo Valls	Plan title: Country road axis. AIII area plan		
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020	SCALE: 1/500 — Plan number: 3.2

POINT(⊕)	EASTING (X)	NORTHING (Y)
P32	627174.35	4701532.55
P33	627151.88	4701521.88
P34	627176.15	4701453.65
P55	627068.80	4701490.27
P56	627065.56	4701494.84
P57	627025.39	4701545.06
P58	627020.42	4701552.57
P59	627003.83	4701583.35
P60	626956.77	4701609.53
P61	626926.74	4701607.70
P62	626908.67	4701609.92
P63	626855.15	4701626.79
P64	626844.04	4701631.85

P64
P63
P62
P61
P60
P59
P58
P57
P56
P55
P33
P32
P34

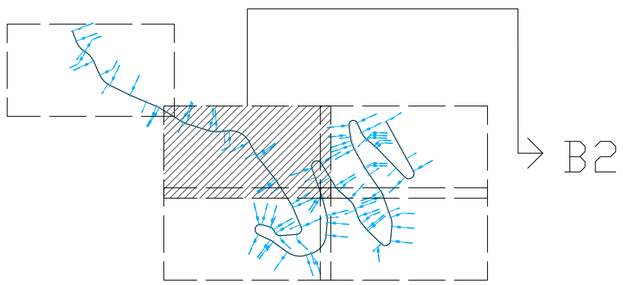
P.K.=1+904.460
P.K.=1+892.217
P.K.=1+836.104
P.K.=1+817.802
P.K.=1+787.708
P.K.=1+730.845
P.K.=1+695.880
P.K.=1+686.862
P.K.=0+975.682
P.K.=1+622.552
P.K.=1+616.949
P.K.=1+552.349

RECTA
R=50
R=12,500
1+900
1+800
1+700
1+600
1+000
0+900

620
600
580
560
540
520

LEGEND

- Axis
- Dimensioning
- Contour lines
- Land registry
- Pre-existing country roads
- Beacon points

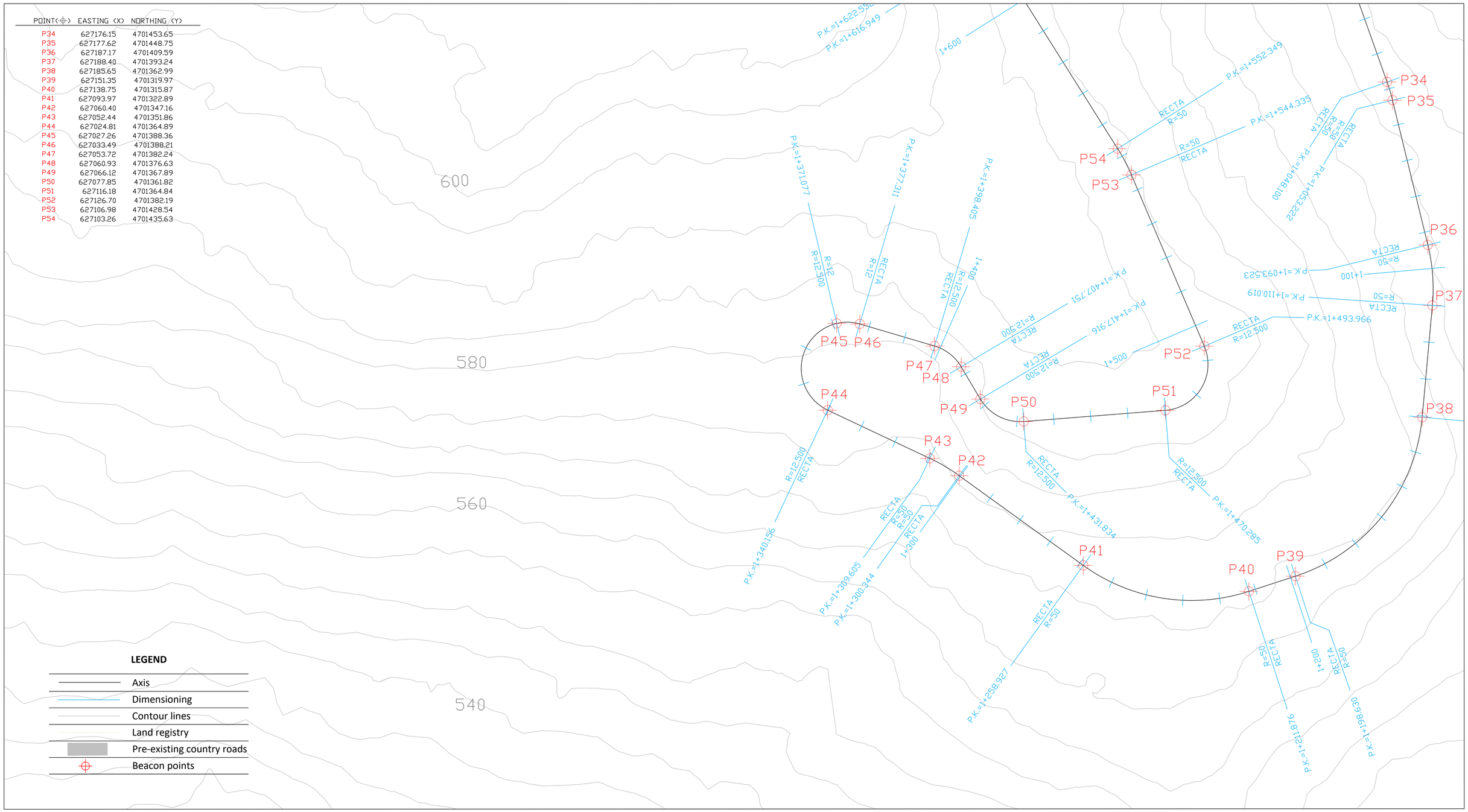


upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

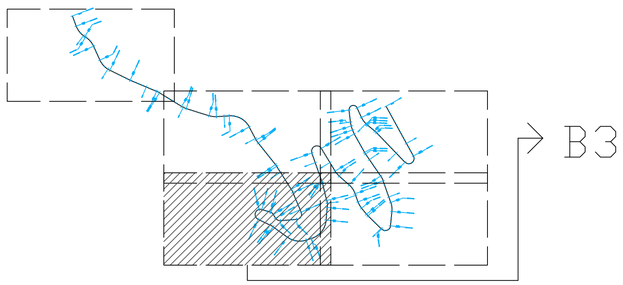
PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_3.3	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road axis. BII area plan	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020
SCALE: 1/500	Plan number: 3.3	

POINT (⊕)	EASTING (X)	NORTHING (Y)
P34	627176.15	4701453.65
P35	627177.62	4701448.75
P36	627187.17	4701409.59
P37	627188.40	4701393.24
P38	627185.65	4701362.99
P39	627151.35	4701319.97
P40	627138.75	4701315.87
P41	627093.97	4701322.89
P42	627060.40	4701347.16
P43	627052.44	4701351.86
P44	627024.81	4701364.89
P45	627027.26	4701388.36
P46	627033.49	4701388.21
P47	627053.72	4701382.24
P48	627060.93	4701376.63
P49	627066.12	4701367.89
P50	627077.85	4701361.82
P51	627116.18	4701364.84
P52	627126.70	4701382.19
P53	627106.98	4701428.54
P54	627103.26	4701435.63



LEGEND

- Axis
- Dimensioning
- Contour lines
- Land registry
- Pre-existing country roads
- Beacon points

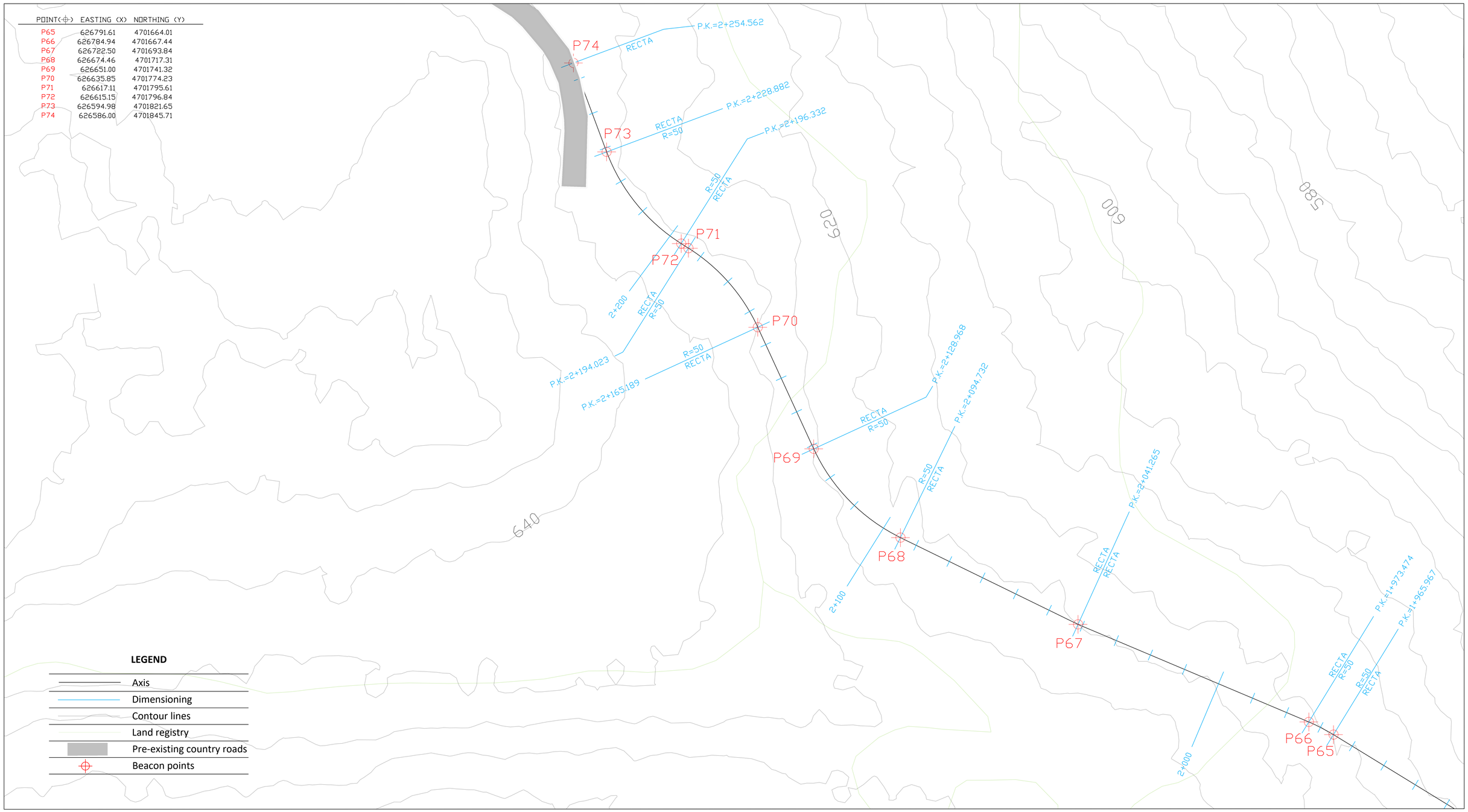


upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

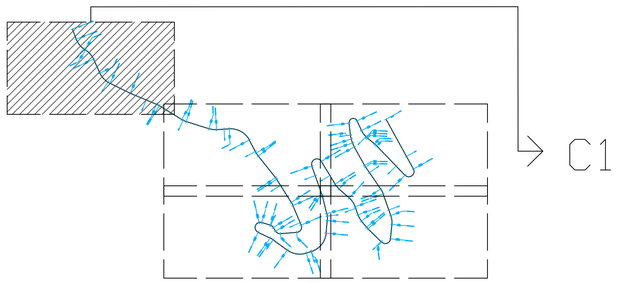
PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_3.4	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road axis. BIII area plan	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020
SCALE: 1/500	Plan number: 3.4	

POINT(⊕)	EASTING (X)	NORTHING (Y)
P65	626791.61	4701664.01
P66	626784.94	4701667.44
P67	626722.50	4701693.84
P68	626674.46	4701717.31
P69	626651.00	4701741.32
P70	626635.85	4701774.23
P71	626617.11	4701795.61
P72	626615.15	4701796.84
P73	626594.98	4701821.65
P74	626586.00	4701845.71



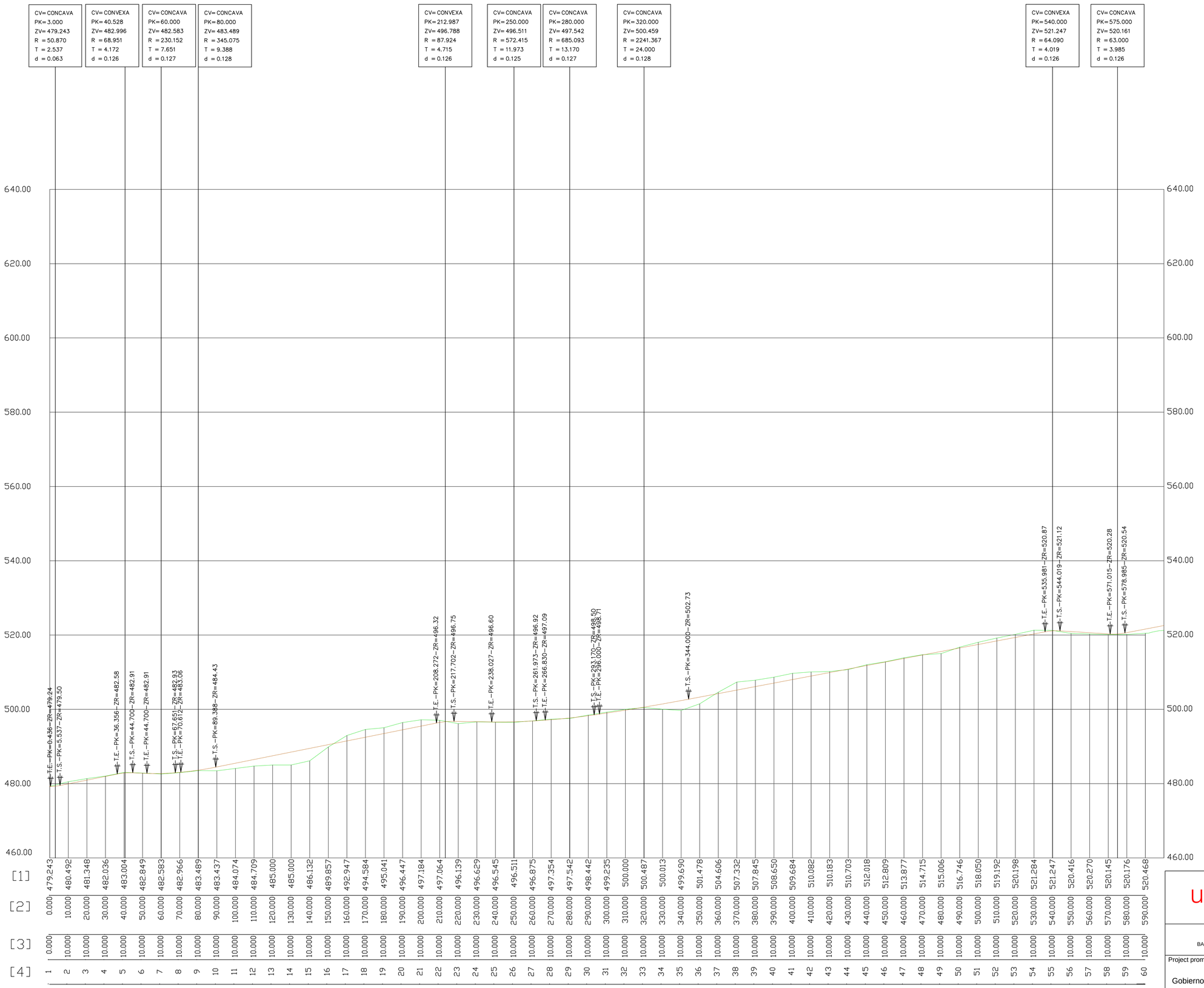
LEGEND

- Axis
- Dimensioning
- Contour lines
- Land registry
- Pre-existing country roads
- Beacon points



upna — College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_3.5	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road axis. CI area plan	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020
SCALE: 1/500	Plan number: 3.5	



[1]: Contours; [2]: Distance to the origin; [3]: Partial distances; [4]: Profile numbers
CV: Transition shape; PK: Kilometric point; ZV: Terrain height; R: Transition radius; T: Tangent; d: Distance; TE: Tangent entrance; TS: Tangent exit; ZR: Grade line height

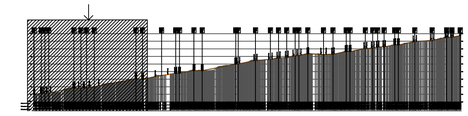
PKinitial (km+m)	PKfinal (km+m)	Slope (%)
0+000,000	0+003,000	0,0000
0+003,000	0+040,528	10,0000
0+040,528	0+060,000	-2,1200
0+060,000	0+080,000	4,5300
0+080,000	0+212+987	10,0000
0+212+987	0+250,000	-0,7375
0+250,000	0+280,000	3,4500
0+280,000	0+320,000	7,2900
0+320,000	0+540,000	9,4490
0+540,000	0+575,000	-3,1045
0+575,000	0+675,385	9,5725

LEGEND

Grade line

Terrain

1st section



upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS
BASIC DOCUMENT

Plan identification code: CRD_MF_LAK_4.1

Review: A

Project promoter: Gobierno de Navarra

Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)

Project maker: Asier Gamallo Valls

Plan title: Longitudinal profile from P.K.=0+000 to P.K.=0+600

Technical reference: Asier Gamallo Valls

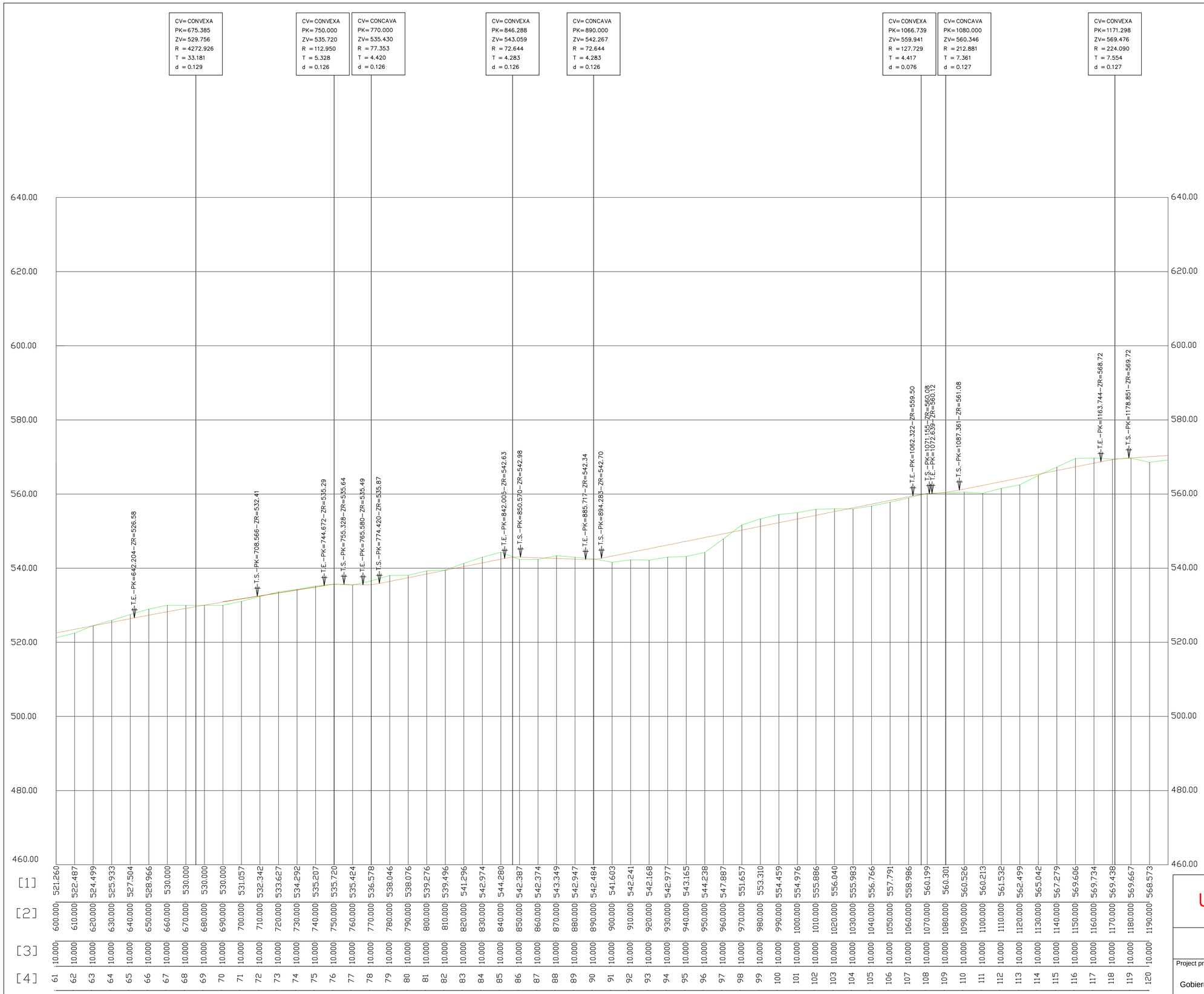
Approved by: Asier Gamallo Valls

Edited (1st time): 13/03/2020

Edited (present): 26/03/2020

SCALE: H: 1/1000 V: 1/2000

Plan number: 4.1



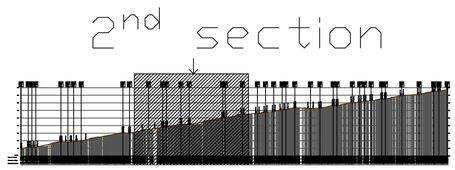
[1]: Contours; [2]: Distance to the origin; [3]: Partial distances; [4]: Profile numbers
CV: Transition shape; PK: Kilometric point; ZV: Terrain height; R: Transition radius; T: Tangent; d: Distance; TE: Tangent entrance; TS: Tangent exit; ZR: Grade line height

PKinitial (km+m)	PKfinal (km+m)	Slope (%)
0+575,000	0+675,385	9,5725
0+675,385	0+750,000	7,9935
0+750,000	0+770,000	-1,4500
0+770,000	0+846,288	10,0000
0+846,288	0+890,000	-1,8115
0+890,000	1+066,739	10,0000
1+066,739	1+080,000	3,0800
1+080,000	1+171,298	10,0000
1+171,298	1+250,000	3,2290

LEGEND

Grade line
Terrain

2nd section



upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS
BASIC DOCUMENT

Plan identification code: CRD_MF_LAK_4.2
Review: A

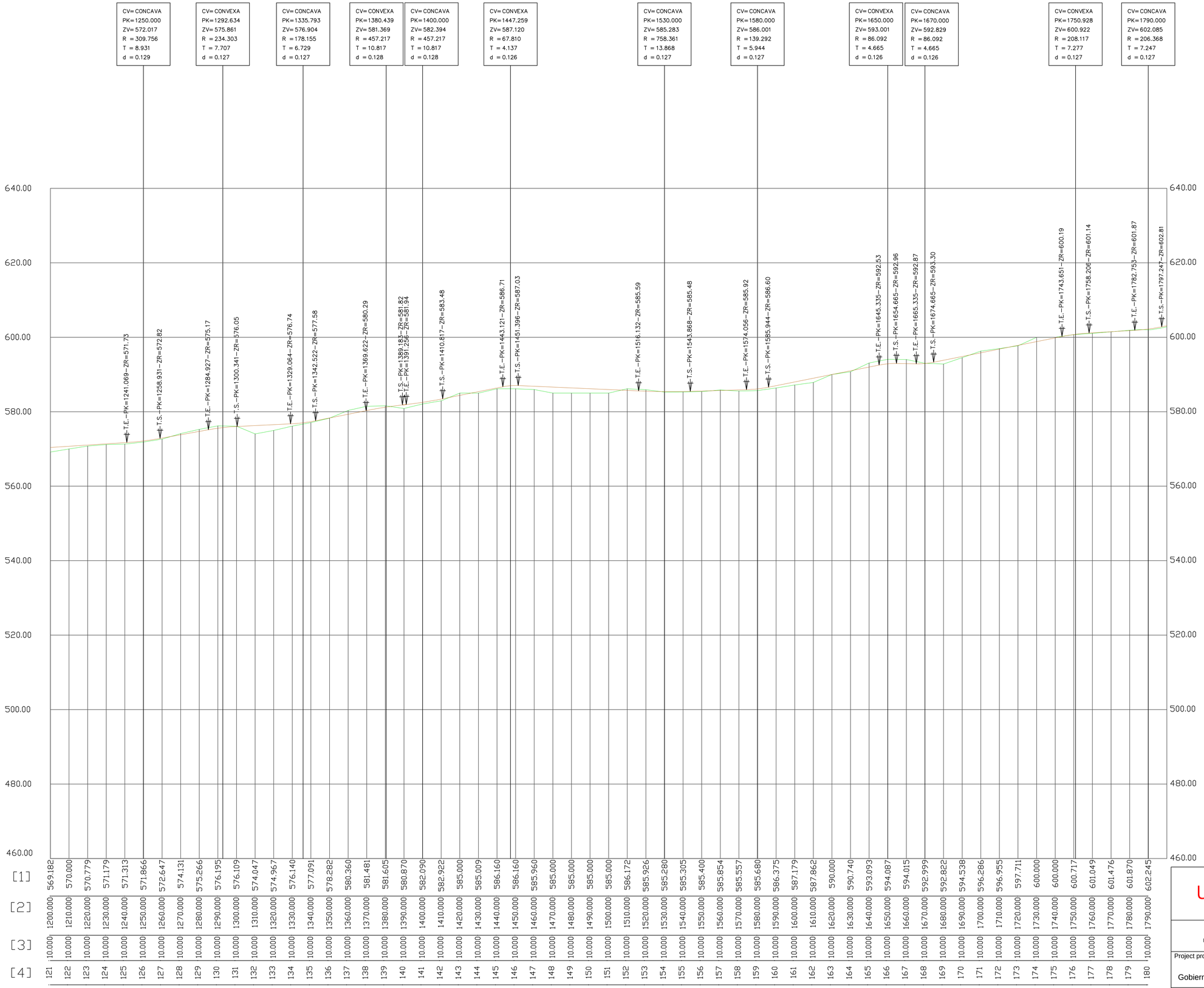
Project promoter: Gobierno de Navarra

Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)

Project maker: Asier Gamallo Valls

Plan title: Longitudinal profile from P.K.=0+600 to P.K.=1+190

Technical reference: Asier Gamallo Valls
Approved by: Asier Gamallo Valls
Edited (1st time): 13/03/2020
Edited (present): 26/03/2020
SCALE: H: 1/1000 V: 1/2000
Plan number: 4.2



[1]	[2]	[3]	[4]
569.182	1200.000	10.000	121
570.000	1210.000	10.000	122
570.779	1220.000	10.000	123
571.179	1230.000	10.000	124
571.313	1240.000	10.000	125
571.866	1250.000	10.000	126
572.647	1260.000	10.000	127
574.131	1270.000	10.000	128
575.266	1280.000	10.000	129
576.195	1290.000	10.000	130
576.109	1300.000	10.000	131
574.047	1310.000	10.000	132
574.967	1320.000	10.000	133
576.140	1330.000	10.000	134
577.091	1340.000	10.000	135
578.282	1350.000	10.000	136
580.360	1360.000	10.000	137
581.481	1370.000	10.000	138
581.605	1380.000	10.000	139
580.870	1390.000	10.000	140
582.090	1400.000	10.000	141
582.922	1410.000	10.000	142
585.000	1420.000	10.000	143
585.009	1430.000	10.000	144
586.160	1440.000	10.000	145
586.160	1450.000	10.000	146
585.960	1460.000	10.000	147
585.000	1470.000	10.000	148
585.000	1480.000	10.000	149
585.000	1490.000	10.000	150
585.000	1500.000	10.000	151
586.172	1510.000	10.000	152
585.926	1520.000	10.000	153
585.280	1530.000	10.000	154
585.305	1540.000	10.000	155
585.400	1550.000	10.000	156
585.854	1560.000	10.000	157
585.557	1570.000	10.000	158
585.680	1580.000	10.000	159
586.375	1590.000	10.000	160
587.179	1600.000	10.000	161
587.862	1610.000	10.000	162
590.000	1620.000	10.000	163
590.740	1630.000	10.000	164
593.093	1640.000	10.000	165
594.087	1650.000	10.000	166
594.015	1660.000	10.000	167
592.999	1670.000	10.000	168
592.822	1680.000	10.000	169
594.538	1690.000	10.000	170
596.286	1700.000	10.000	171
596.955	1710.000	10.000	172
597.711	1720.000	10.000	173
600.000	1730.000	10.000	174
600.000	1740.000	10.000	175
600.717	1750.000	10.000	176
601.049	1760.000	10.000	177
601.476	1770.000	10.000	178
601.870	1780.000	10.000	179
602.245	1790.000	10.000	180

[1]: Contours; [2]: Distance to the origin; [3]: Partial distances; [4]: Profile numbers
CV: Transition shape; PK: Kilometric point; ZV: Terrain height; R: Transition radius; T: Tangent; d: Distance; TE: Tangent entrance; TS: Tangent exit; ZR: Grade line height

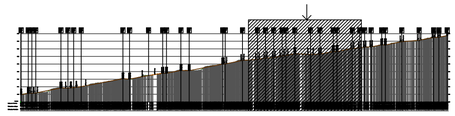
PKinitial (km+m)	PKfinal (km+m)	Slope (%)
1+171,298	1+250,000	3,2290
1+250,000	1+292,634	9,0180
1+292,634	1+335,793	2,4165
1+335,793	1+380,439	10,0035
1+380,439	1+400,000	5,7050
1+400,000	1+447,259	10,0000
1+447,259	1+530,000	-2,2250
1+530,000	1+580,000	1,4370
1+580,000	1+650,000	10,0000
1+650,000	1+670,000	-0,8500
1+670,000	1+750,928	10,0000
1+750,928	1+790,000	2,9770
1+790,000	1+815,795	10,0315

LEGEND

Grade line

Terrain

3rd section



upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS
BASIC DOCUMENT

Plan identification code: CRD_MF_LAK_4.3

Review: A

Project promoter: Gobierno de Navarra

Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)

Project maker: Asier Gamallo Valls

Plan title: Longitudinal profile from P.K.=1+190 to P.K.=1+790

Technical reference: Asier Gamallo Valls

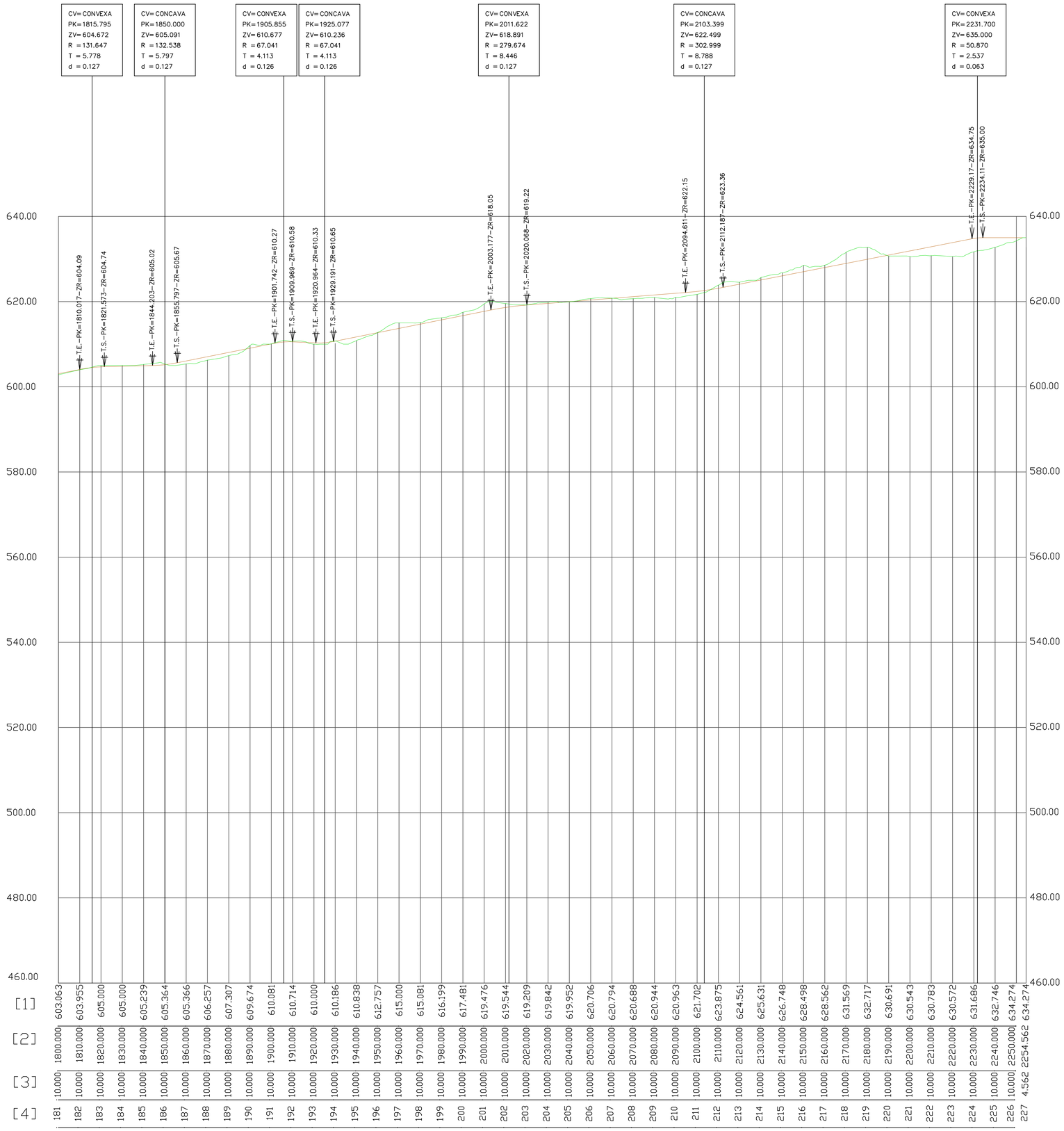
Approved by: Asier Gamallo Valls

Edited (1st time): 13/03/2020

Edited (present): 26/03/2020

SCALE: H: 1/1000 V: 1/2000

Plan number: 4.3



[1]: Contours; [2]: Distance to the origin; [3]: Partial distances; [4]: Profile numbers
CV: Transition shape; PK: Kilometric point; ZV: Terrain height; R: Transition radius; T: Tangent; d: Distance; TE: Tangent entrance; TS: Tangent exit; ZR: Grade line height

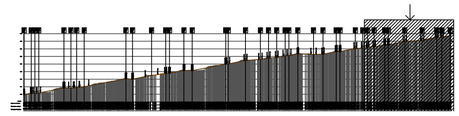
PKinitial (km+m)	PKfinal (km+m)	Slope (%)
1+790,000	1+815,795	10,0315
1+815,795	1+850,000	1,2240
1+850,000	1+905,855	10,0000
1+905,855	1+925,077	-2,2895
1+925,077	2+011,622	10,0000
2+011,622	2+103,399	3,9290
2+103,399	2+231,700	10.0000
2+231,700	2+254,562	0,0000

LEGEND

Grade line

Terrain

4th section



upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS
BASIC DOCUMENT

Plan identification code: CRD_MF_LAK_4.4

Review: A

Project promoter: Gobierno de Navarra

Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)

Project maker: Asier Gamallo Valls

Plan title: Longitudinal profile from P.K.=1+790 to P.K.=2+254

Technical reference: Asier Gamallo Valls

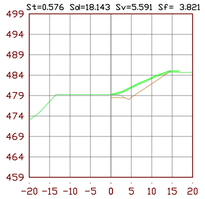
Approved by: Asier Gamallo Valls

Edited (1st time): 13/03/2020

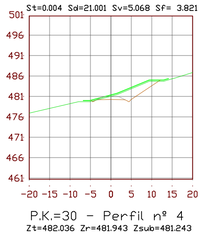
Edited (present): 26/03/2020

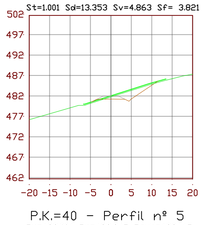
SCALE: H: 1/1000 V: 1/2000

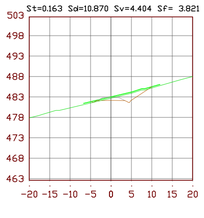
Plan number: 4.4

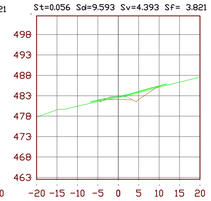
P.K.=0 - Perfil nº 1
Zt=479.243 Zr=479.243 Zsub=478.543
St=0.576 Sd=18.143 Sv=5.591 Sf= 3.821


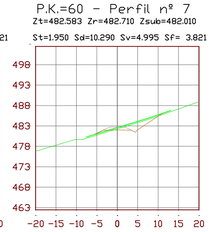
P.K.=10 - Perfil nº 2
Zt=480.492 Zr=479.943 Zsub=479.243
St=0.032 Sd=23.916 Sv=5.543 Sf= 3.821

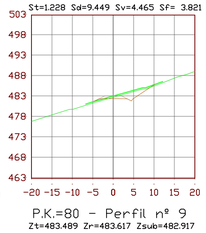

P.K.=20 - Perfil nº 3
Zt=481.348 Zr=480.943 Zsub=480.243
St=0.004 Sd=21.001 Sv=5.068 Sf= 3.821


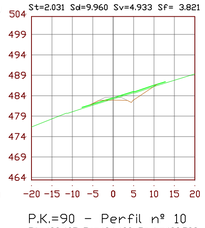
P.K.=30 - Perfil nº 4
Zt=482.036 Zr=481.943 Zsub=481.243
St=1.001 Sd=13.353 Sv=4.863 Sf= 3.821


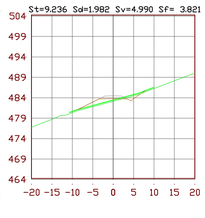
P.K.=40 - Perfil nº 5
Zt=483.004 Zr=482.847 Zsub=482.147
St=0.163 Sd=10.870 Sv=4.404 Sf= 3.821


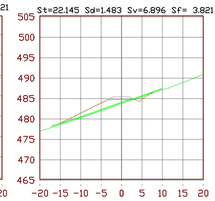
P.K.=50 - Perfil nº 6
Zt=482.849 Zr=482.795 Zsub=482.095
St=0.056 Sd=9.593 Sv=4.393 Sf= 3.821


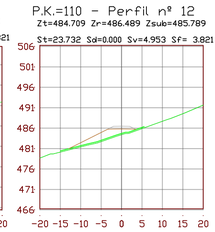
P.K.=60 - Perfil nº 7
Zt=482.583 Zr=482.710 Zsub=482.010
St=1.950 Sd=10.290 Sv=4.995 Sf= 3.821


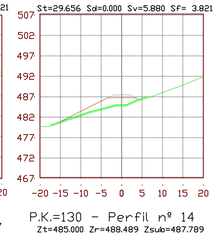
P.K.=70 - Perfil nº 8
Zt=482.966 Zr=483.036 Zsub=482.336
St=1.228 Sd=9.449 Sv=4.465 Sf= 3.821


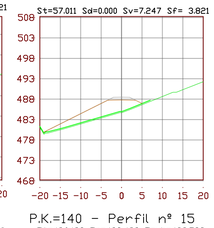
P.K.=80 - Perfil nº 9
Zt=483.489 Zr=483.617 Zsub=482.917
St=2.031 Sd=9.960 Sv=4.933 Sf= 3.821


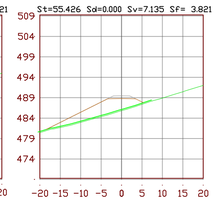
P.K.=90 - Perfil nº 10
Zt=483.437 Zr=484.489 Zsub=483.789
St=9.236 Sd=1.982 Sv=4.990 Sf= 3.821


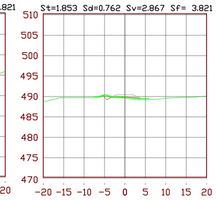
P.K.=100 - Perfil nº 11
Zt=484.074 Zr=485.489 Zsub=484.789
St=22.145 Sd=1.483 Sv=6.896 Sf= 3.821


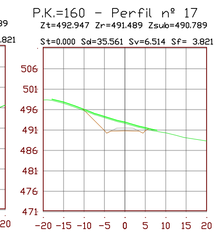
P.K.=110 - Perfil nº 12
Zt=484.709 Zr=486.489 Zsub=485.789
St=23.732 Sd=0.000 Sv=4.953 Sf= 3.821


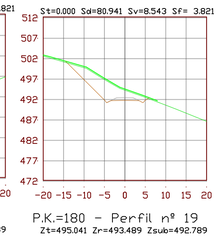
P.K.=120 - Perfil nº 13
Zt=485.000 Zr=487.489 Zsub=486.789
St=29.656 Sd=0.000 Sv=5.880 Sf= 3.821


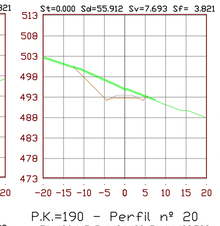
P.K.=130 - Perfil nº 14
Zt=485.000 Zr=488.489 Zsub=487.789
St=57.011 Sd=0.000 Sv=7.247 Sf= 3.821


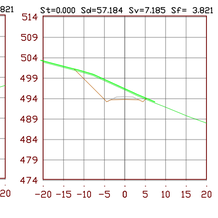
P.K.=140 - Perfil nº 15
Zt=486.132 Zr=489.489 Zsub=488.789
St=55.426 Sd=0.000 Sv=7.135 Sf= 3.821


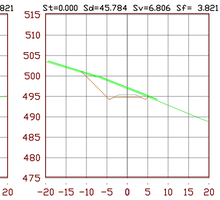
P.K.=150 - Perfil nº 16
Zt=489.857 Zr=490.489 Zsub=489.789
St=1.853 Sd=0.762 Sv=2.867 Sf= 3.821


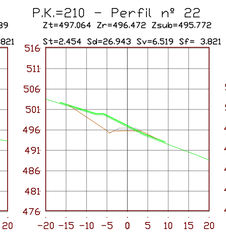
P.K.=160 - Perfil nº 17
Zt=492.947 Zr=491.489 Zsub=490.789
St=0.000 Sd=35.561 Sv=6.514 Sf= 3.821


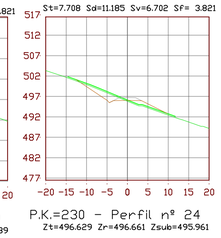
P.K.=170 - Perfil nº 18
Zt=494.584 Zr=492.489 Zsub=491.789
St=0.000 Sd=80.941 Sv=8.543 Sf= 3.821


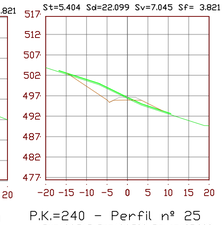
P.K.=180 - Perfil nº 19
Zt=495.041 Zr=493.489 Zsub=492.789
St=0.000 Sd=55.912 Sv=7.693 Sf= 3.821


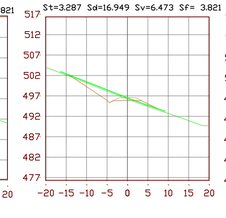
P.K.=190 - Perfil nº 20
Zt=496.447 Zr=494.489 Zsub=493.789
St=0.000 Sd=57.184 Sv=7.185 Sf= 3.821


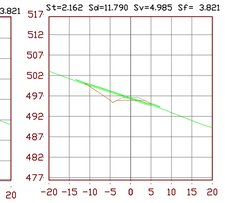
P.K.=200 - Perfil nº 21
Zt=497.184 Zr=495.489 Zsub=494.789
St=0.000 Sd=45.784 Sv=6.806 Sf= 3.821


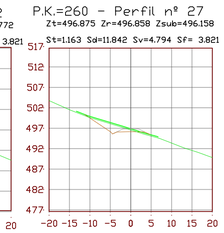
P.K.=210 - Perfil nº 22
Zt=497.064 Zr=496.472 Zsub=495.772
St=2.454 Sd=26.943 Sv=6.519 Sf= 3.821


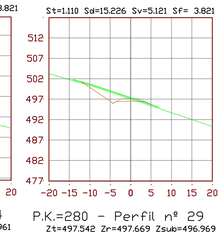
P.K.=220 - Perfil nº 23
Zt=496.139 Zr=496.735 Zsub=496.035
St=7.708 Sd=11.185 Sv=6.702 Sf= 3.821


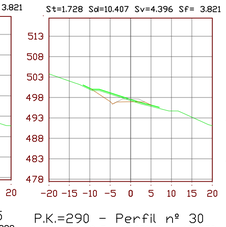
P.K.=230 - Perfil nº 24
Zt=496.629 Zr=496.661 Zsub=495.961
St=5.404 Sd=22.099 Sv=7.045 Sf= 3.821


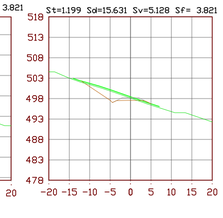
P.K.=240 - Perfil nº 25
Zt=496.545 Zr=496.589 Zsub=495.889
St=3.287 Sd=16.949 Sv=6.473 Sf= 3.821


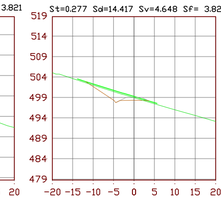
P.K.=250 - Perfil nº 26
Zt=496.511 Zr=496.636 Zsub=495.936
St=2.162 Sd=11.790 Sv=4.985 Sf= 3.821


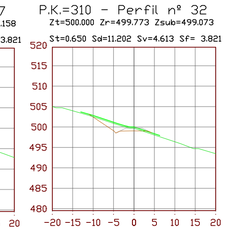
P.K.=260 - Perfil nº 27
Zt=496.875 Zr=496.858 Zsub=496.158
St=1.163 Sd=11.842 Sv=4.794 Sf= 3.821


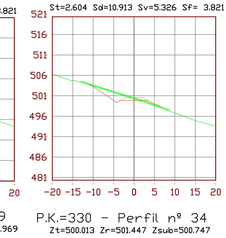
P.K.=270 - Perfil nº 28
Zt=497.354 Zr=497.206 Zsub=496.506
St=1.110 Sd=15.226 Sv=5.121 Sf= 3.821


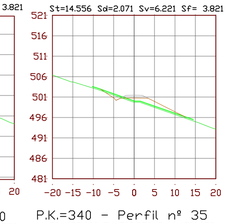
P.K.=280 - Perfil nº 29
Zt=497.542 Zr=497.669 Zsub=496.969
St=1.728 Sd=10.407 Sv=4.396 Sf= 3.821


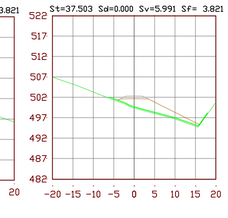
P.K.=290 - Perfil nº 30
Zt=498.442 Zr=498.279 Zsub=497.579
St=1.199 Sd=15.631 Sv=5.128 Sf= 3.821


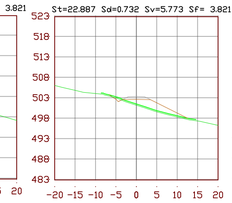
P.K.=300 - Perfil nº 31
Zt=499.235 Zr=499.004 Zsub=498.304
St=0.277 Sd=14.417 Sv=4.648 Sf= 3.821


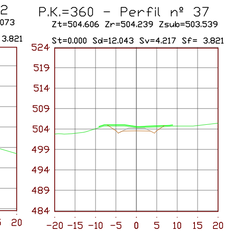
P.K.=310 - Perfil nº 32
Zt=500.000 Zr=499.773 Zsub=499.073
St=0.650 Sd=11.202 Sv=4.613 Sf= 3.821


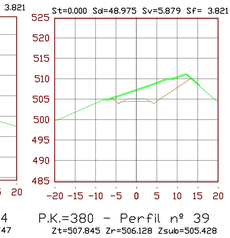
P.K.=320 - Perfil nº 33
Zt=500.487 Zr=500.587 Zsub=499.887
St=2.604 Sd=10.913 Sv=5.326 Sf= 3.821


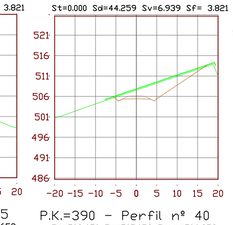
P.K.=330 - Perfil nº 34
Zt=500.013 Zr=501.447 Zsub=500.747
St=14.556 Sd=2.071 Sv=6.221 Sf= 3.821


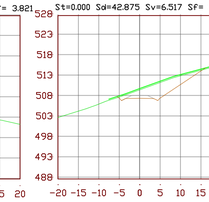
P.K.=340 - Perfil nº 35
Zt=499.690 Zr=502.352 Zsub=501.652
St=37.503 Sd=0.000 Sv=5.991 Sf= 3.821


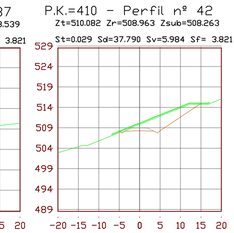
P.K.=350 - Perfil nº 36
Zt=501.478 Zr=503.294 Zsub=502.594
St=22.887 Sd=0.732 Sv=5.773 Sf= 3.821


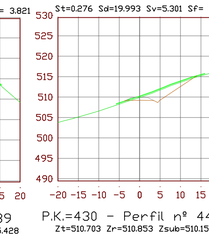
P.K.=360 - Perfil nº 37
Zt=504.606 Zr=504.239 Zsub=503.539
St=0.000 Sd=12.043 Sv=4.217 Sf= 3.821


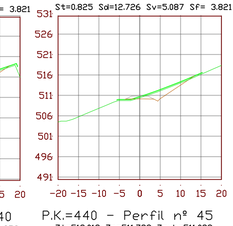
P.K.=370 - Perfil nº 38
Zt=507.332 Zr=505.184 Zsub=504.484
St=0.000 Sd=48.975 Sv=5.879 Sf= 3.821


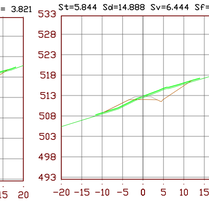
P.K.=380 - Perfil nº 39
Zt=507.845 Zr=506.128 Zsub=505.428
St=0.000 Sd=44.259 Sv=6.939 Sf= 3.821


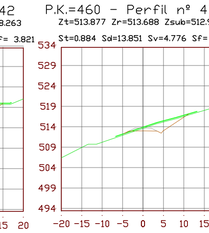
P.K.=380 - Perfil nº 39
Zt=501.478 Zr=503.294 Zsub=502.594
St=22.887 Sd=0.732 Sv=5.773 Sf= 3.821


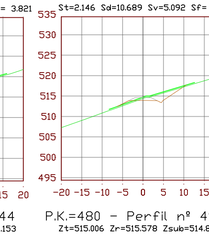
P.K.=360 - Perfil nº 37
Zt=504.606 Zr=504.239 Zsub=503.539
St=0.000 Sd=12.043 Sv=4.217 Sf= 3.821


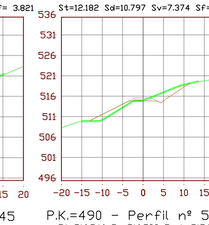
P.K.=370 - Perfil nº 38
Zt=507.332 Zr=505.184 Zsub=504.484
St=0.000 Sd=48.975 Sv=5.879 Sf= 3.821


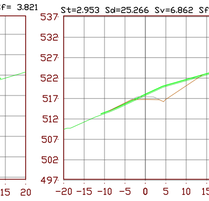
P.K.=380 - Perfil nº 39
Zt=507.845 Zr=506.128 Zsub=505.428
St=0.000 Sd=44.259 Sv=6.939 Sf= 3.821


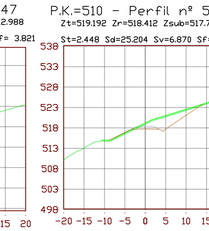
P.K.=400 - Perfil nº 41
Zt=509.684 Zr=508.018 Zsub=507.318
St=0.000 Sd=42.875 Sv=6.517 Sf= 3.821


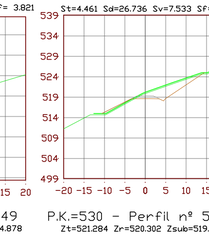
P.K.=410 - Perfil nº 42
Zt=510.082 Zr=508.963 Zsub=508.263
St=0.029 Sd=37.790 Sv=5.984 Sf= 3.821


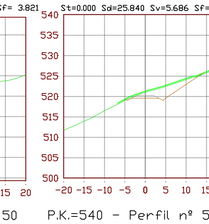
P.K.=420 - Perfil nº 43
Zt=510.183 Zr=509.908 Zsub=509.208
St=0.276 Sd=19.993 Sv=5.301 Sf= 3.821


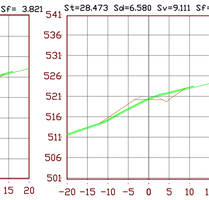
P.K.=430 - Perfil nº 44
Zt=510.703 Zr=510.853 Zsub=510.153
St=0.825 Sd=12.726 Sv=5.087 Sf= 3.821


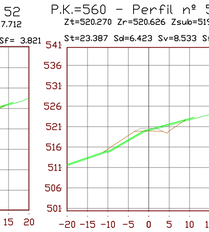
P.K.=430 - Perfil nº 44
Zt=510.018 Zr=508.018 Zsub=507.318
St=0.000 Sd=42.875 Sv=6.517 Sf= 3.821


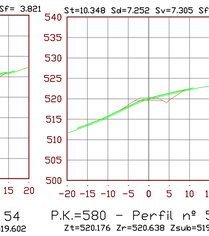
P.K.=410 - Perfil nº 42
Zt=510.082 Zr=508.963 Zsub=508.263
St=0.029 Sd=37.790 Sv=5.984 Sf= 3.821


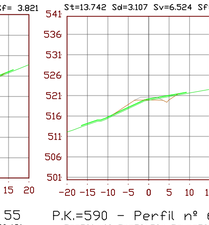
P.K.=420 - Perfil nº 43
Zt=510.183 Zr=509.908 Zsub=509.208
St=0.276 Sd=19.993 Sv=5.301 Sf= 3.821


P.K.=430 - Perfil nº 44
Zt=510.853 Zr=510.153
St=0.825 Sd=12.726 Sv=5.087 Sf= 3.821


P.K.=450 - Perfil nº 46
Zt=512.809 Zr=512.743 Zsub=512.043
St=5.844 Sd=14.888 Sv=6.444 Sf= 3.821


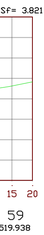
P.K.=460 - Perfil nº 47
Zt=513.877 Zr=513.688 Zsub=512.988
St=0.884 Sd=13.851 Sv=4.776 Sf= 3.821


P.K.=470 - Perfil nº 48
Zt=514.715 Zr=514.633 Zsub=513.933
St=2.146 Sd=10.689 Sv=5.092 Sf= 3.821


P.K.=480 - Perfil nº 49
Zt=515.006 Zr=515.578 Zsub=514.878
St=12.182 Sd=10.797 Sv=7.374 Sf= 3.821


P.K.=500 - Perfil nº 51
Zt=518.050 Zr=517.467 Zsub=516.767
St=2.953 Sd=25.266 Sv=6.862 Sf= 3.821


P.K.=510 - Perfil nº 52
Zt=519.192 Zr=518.412 Zsub=517.712
St=2.448 Sd=25.204 Sv=6.870 Sf= 3.821


P.K.=520 - Perfil nº 53
Zt=520.198 Zr=519.357 Zsub=518.657
St=4.461 Sd=26.736 Sv=7.533 Sf= 3.821


P.K.=530 - Perfil nº 54
Zt=521.284 Zr=520.302 Zsub=519.602
St=0.000 Sd=25.840 Sv=5.686 Sf= 3.821


P.K.=540 - Perfil nº 55
Zt=521.247 Zr=521.121 Zsub=520.421
St=14.819 Sd=24.555 Sv=13.744 Sf= 3.821


P.K.=550 - Perfil nº 56
Zt=520.416 Zr=520.937 Zsub=520.237
St=28.473 Sd=6.580 Sv=9.111 Sf= 3.821

P.K.=560 - Perfil nº 57
Zt=520.270 Zr=520.626 Zsub=519.926
St=23.387 Sd=6.423 Sv=8.533 Sf= 3.821

P.K.=570 - Perfil nº 58
Zt=520.145 Zr=520.316 Zsub=519.616
St=10.348 Sd=7.252 Sv=7.305 Sf= 3.821

P.K.=580 - Perfil nº 59
Zt=520.176 Zr=520.638 Zsub=519.938
St=13.742 Sd=3.107 Sv=6.524 Sf= 3.821

P.K.=590 - Perfil nº 60
Zt=520.468 Zr=521.594 Zsub=520.894
St=9.634 Sd=1.629 Sv=5.280 Sf= 3.821

Zt: Terrain height ; Zr: Grade line height ; Zsub: Subgrade height ; St: Fill surface ; Sd: Cut surface ; Sv: Topsoil surface ; Sf: Base s

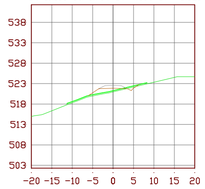
LEGEND

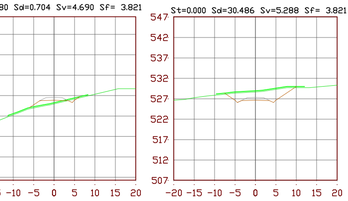
- Terrain
- Topsoil
- Base
- Subgrade and earth-works

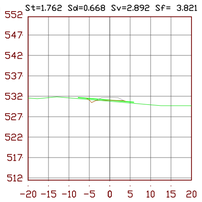
upna

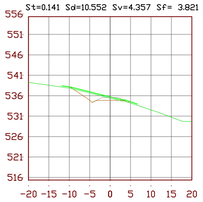
College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

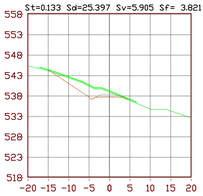
PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_5.1	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road cross-sections on the modified ground I	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 05/04/2020
SCALE: 1/750	Plan number: 5.1	

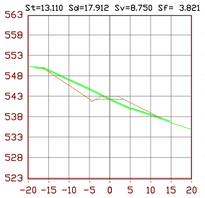
P.K.=600 - Perfil nº 61
Zt=521.260 Zr=522.550 Zsub=521.850
St=10.180 Sd=0.704 Sv=4.690 Sf= 3.821


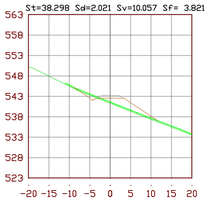
P.K.=650 - Perfil nº 66
Zt=528.966 Zr=527.322 Zsub=526.622
St=0.000 Sd=30.486 Sv=5.288 Sf= 3.821


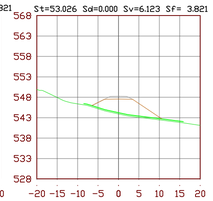
P.K.=700 - Perfil nº 71
Zt=531.057 Zr=531.715 Zsub=531.015
St=1.762 Sd=0.668 Sv=2.892 Sf= 3.821


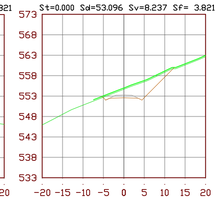
P.K.=750 - Perfil nº 76
Zt=535.720 Zr=535.594 Zsub=534.894
St=0.141 Sd=10.552 Sv=4.357 Sf= 3.821


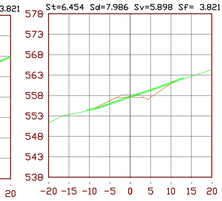
P.K.=800 - Perfil nº 81
Zt=539.276 Zr=538.430 Zsub=537.730
St=0.133 Sd=25.397 Sv=5.905 Sf= 3.821


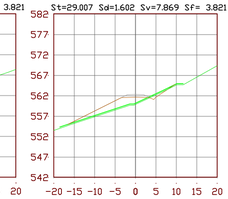
P.K.=850 - Perfil nº 86
Zt=542.387 Zr=542.989 Zsub=542.289
St=13.110 Sd=17.912 Sv=8.750 Sf= 3.821


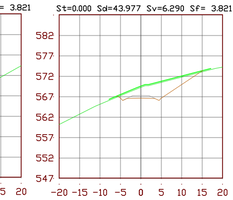
P.K.=900 - Perfil nº 91
Zt=541.603 Zr=543.267 Zsub=542.567
St=38.298 Sd=2.021 Sv=10.057 Sf= 3.821


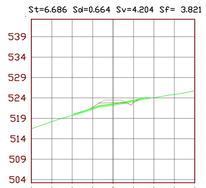
P.K.=950 - Perfil nº 96
Zt=544.238 Zr=548.267 Zsub=547.567
St=53.026 Sd=0.000 Sv=6.123 Sf= 3.821


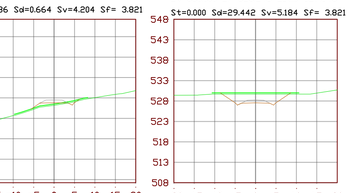
P.K.=1000 - Perfil nº 101
Zt=554.976 Zr=553.267 Zsub=552.567
St=0.000 Sd=53.096 Sv=8.237 Sf= 3.821


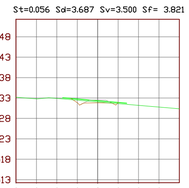
P.K.=1050 - Perfil nº 106
Zt=557.791 Zr=558.267 Zsub=557.567
St=6.454 Sd=7.986 Sv=5.898 Sf= 3.821


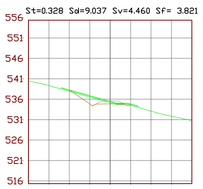
P.K.=1100 - Perfil nº 111
Zt=560.213 Zr=562.346 Zsub=561.646
St=29.007 Sd=1.602 Sv=7.869 Sf= 3.821


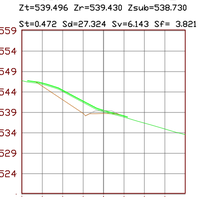
P.K.=1150 - Perfil nº 116
Zt=569.606 Zr=567.346 Zsub=566.646
St=0.000 Sd=43.977 Sv=6.290 Sf= 3.821


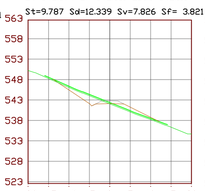
P.K.=610 - Perfil nº 62
Zt=522.487 Zr=523.506 Zsub=522.806
St=6.686 Sd=0.664 Sv=4.204 Sf= 3.821


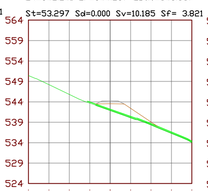
P.K.=660 - Perfil nº 67
Zt=530.000 Zr=528.248 Zsub=527.548
St=0.000 Sd=29.442 Sv=5.184 Sf= 3.821


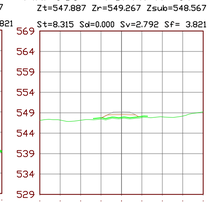
P.K.=710 - Perfil nº 72
Zt=532.342 Zr=532.523 Zsub=531.823
St=0.056 Sd=3.687 Sv=3.500 Sf= 3.821


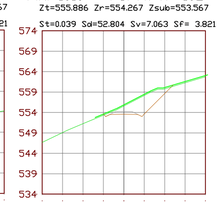
P.K.=760 - Perfil nº 77
Zt=535.424 Zr=535.575 Zsub=534.875
St=0.328 Sd=9.037 Sv=4.460 Sf= 3.821


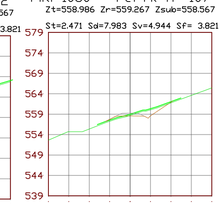
P.K.=810 - Perfil nº 82
Zt=539.496 Zr=539.430 Zsub=538.730
St=0.472 Sd=27.324 Sv=6.143 Sf= 3.821


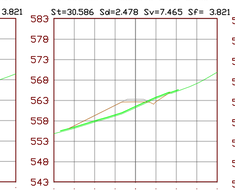
P.K.=860 - Perfil nº 87
Zt=542.374 Zr=542.810 Zsub=542.110
St=9.787 Sd=12.339 Sv=7.826 Sf= 3.821


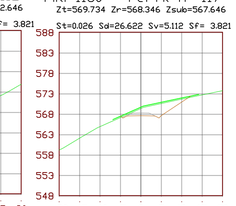
P.K.=910 - Perfil nº 92
Zt=542.241 Zr=544.267 Zsub=543.567
St=53.297 Sd=0.000 Sv=10.185 Sf= 3.821


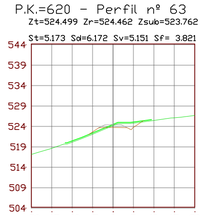
P.K.=960 - Perfil nº 97
Zt=547.887 Zr=549.267 Zsub=548.567
St=8.315 Sd=0.000 Sv=2.792 Sf= 3.821


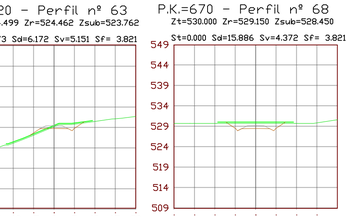
P.K.=1010 - Perfil nº 102
Zt=555.886 Zr=554.267 Zsub=553.567
St=0.039 Sd=52.804 Sv=7.063 Sf= 3.821


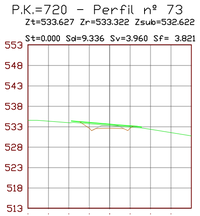
P.K.=1060 - Perfil nº 107
Zt=558.986 Zr=559.267 Zsub=558.567
St=2.471 Sd=7.983 Sv=4.944 Sf= 3.821


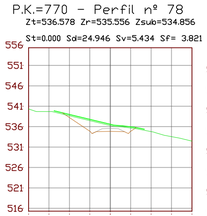
P.K.=1110 - Perfil nº 112
Zt=561.532 Zr=563.346 Zsub=562.646
St=30.586 Sd=2.478 Sv=7.465 Sf= 3.821


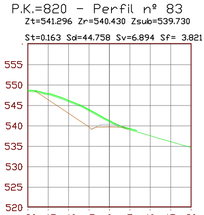
P.K.=1160 - Perfil nº 117
Zt=569.734 Zr=568.346 Zsub=567.646
St=0.026 Sd=26.622 Sv=5.112 Sf= 3.821


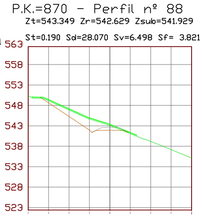
P.K.=620 - Perfil nº 63
Zt=524.499 Zr=524.462 Zsub=523.762
St=5.173 Sd=6.172 Sv=5.151 Sf= 3.821


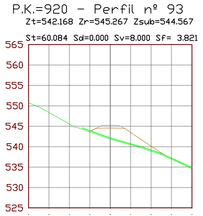
P.K.=670 - Perfil nº 68
Zt=530.000 Zr=529.150 Zsub=528.450
St=0.000 Sd=15.886 Sv=4.372 Sf= 3.821


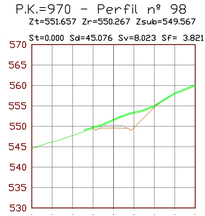
P.K.=720 - Perfil nº 73
Zt=533.627 Zr=533.322 Zsub=532.622
St=0.000 Sd=9.336 Sv=3.960 Sf= 3.821


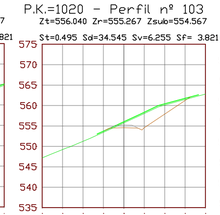
P.K.=770 - Perfil nº 78
Zt=536.578 Zr=535.556 Zsub=534.856
St=0.000 Sd=24.946 Sv=5.434 Sf= 3.821


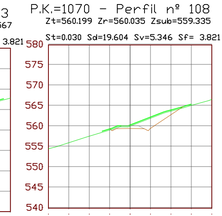
P.K.=820 - Perfil nº 83
Zt=541.296 Zr=540.430 Zsub=539.730
St=0.163 Sd=44.758 Sv=6.894 Sf= 3.821


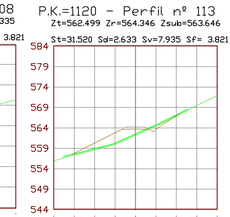
P.K.=870 - Perfil nº 88
Zt=543.349 Zr=542.629 Zsub=541.929
St=0.190 Sd=28.070 Sv=6.498 Sf= 3.821


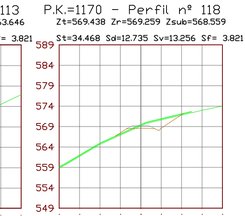
P.K.=920 - Perfil nº 93
Zt=542.168 Zr=545.267 Zsub=544.567
St=60.084 Sd=0.000 Sv=8.000 Sf= 3.821


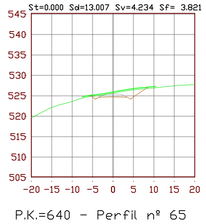
P.K.=970 - Perfil nº 98
Zt=551.657 Zr=550.267 Zsub=549.567
St=0.000 Sd=45.076 Sv=8.023 Sf= 3.821


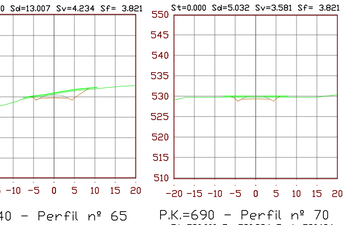
P.K.=1020 - Perfil nº 103
Zt=556.040 Zr=555.267 Zsub=554.567
St=0.495 Sd=34.545 Sv=6.255 Sf= 3.821


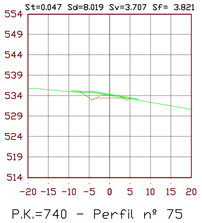
P.K.=1070 - Perfil nº 108
Zt=560.199 Zr=560.035 Zsub=559.335
St=0.030 Sd=19.604 Sv=5.346 Sf= 3.821


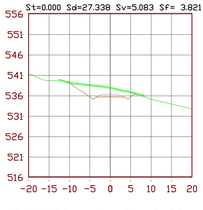
P.K.=1120 - Perfil nº 113
Zt=562.499 Zr=564.346 Zsub=563.646
St=31.520 Sd=2.633 Sv=7.935 Sf= 3.821


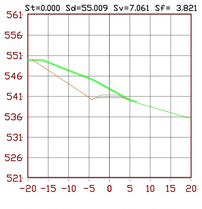
P.K.=1170 - Perfil nº 118
Zt=569.438 Zr=569.259 Zsub=568.559
St=34.468 Sd=12.735 Sv=13.256 Sf= 3.821


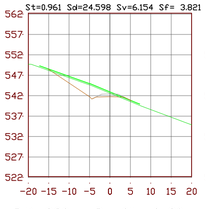
P.K.=630 - Perfil nº 64
Zt=525.933 Zr=525.418 Zsub=524.718
St=0.000 Sd=13.007 Sv=4.234 Sf= 3.821


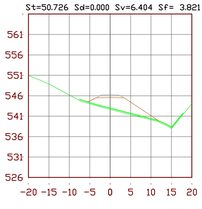
P.K.=680 - Perfil nº 69
Zt=530.000 Zr=530.029 Zsub=529.329
St=0.000 Sd=5.032 Sv=3.581 Sf= 3.821


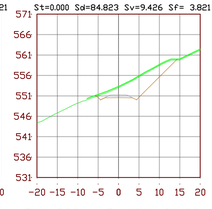
P.K.=730 - Perfil nº 74
Zt=534.292 Zr=534.121 Zsub=533.421
St=0.047 Sd=8.019 Sv=3.707 Sf= 3.821


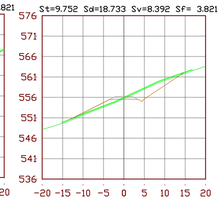
P.K.=780 - Perfil nº 79
Zt=538.046 Zr=536.430 Zsub=535.730
St=0.000 Sd=27.338 Sv=5.083 Sf= 3.821


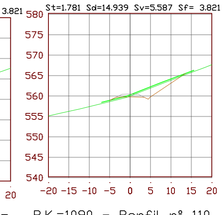
P.K.=830 - Perfil nº 84
Zt=542.974 Zr=541.430 Zsub=540.730
St=0.000 Sd=55.009 Sv=7.061 Sf= 3.821


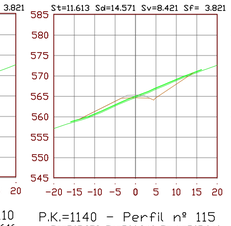
P.K.=880 - Perfil nº 89
Zt=542.947 Zr=542.448 Zsub=541.748
St=0.961 Sd=24.598 Sv=6.154 Sf= 3.821


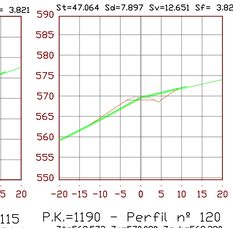
P.K.=930 - Perfil nº 94
Zt=542.977 Zr=546.267 Zsub=545.567
St=50.726 Sd=0.000 Sv=6.404 Sf= 3.821


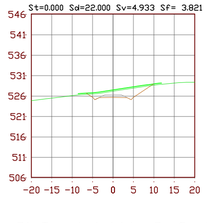
P.K.=980 - Perfil nº 99
Zt=553.310 Zr=551.267 Zsub=550.567
St=0.000 Sd=84.823 Sv=9.426 Sf= 3.821


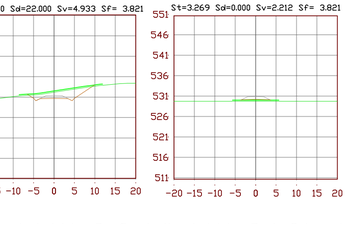
P.K.=1030 - Perfil nº 104
Zt=555.983 Zr=556.267 Zsub=555.567
St=9.752 Sd=18.733 Sv=8.392 Sf= 3.821


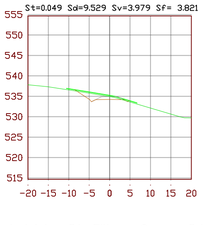
P.K.=1080 - Perfil nº 109
Zt=560.301 Zr=560.473 Zsub=559.773
St=1.781 Sd=14.939 Sv=5.587 Sf= 3.821


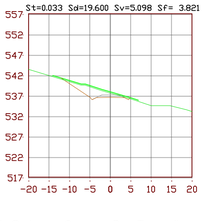
P.K.=1130 - Perfil nº 114
Zt=565.042 Zr=565.346 Zsub=564.646
St=11.613 Sd=14.571 Sv=8.421 Sf= 3.821


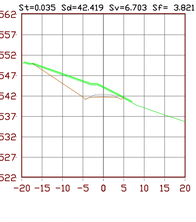
P.K.=1180 - Perfil nº 119
Zt=569.667 Zr=569.757 Zsub=569.057
St=47.064 Sd=7.897 Sv=12.651 Sf= 3.821


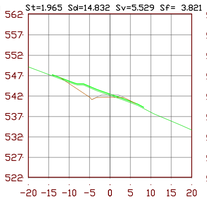
P.K.=640 - Perfil nº 65
Zt=527.504 Zr=526.373 Zsub=525.673
St=0.000 Sd=22.000 Sv=4.933 Sf= 3.821


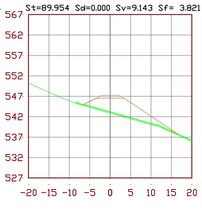
P.K.=690 - Perfil nº 70
Zt=530.000 Zr=530.884 Zsub=530.184
St=3.269 Sd=0.000 Sv=2.212 Sf= 3.821


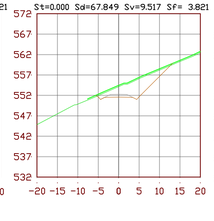
P.K.=740 - Perfil nº 75
Zt=535.207 Zr=534.921 Zsub=534.221
St=0.049 Sd=9.529 Sv=3.979 Sf= 3.821


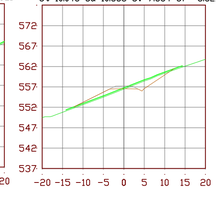
P.K.=790 - Perfil nº 80
Zt=538.076 Zr=537.430 Zsub=536.730
St=0.033 Sd=19.600 Sv=5.098 Sf= 3.821


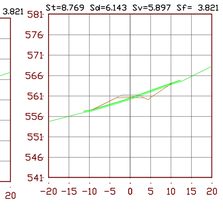
P.K.=840 - Perfil nº 85
Zt=544.280 Zr=542.430 Zsub=541.730
St=0.035 Sd=42.419 Sv=6.703 Sf= 3.821


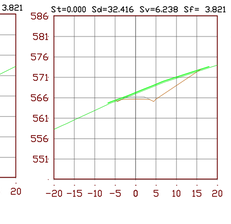
P.K.=890 - Perfil nº 90
Zt=542.484 Zr=542.393 Zsub=541.693
St=1.965 Sd=14.832 Sv=5.529 Sf= 3.821


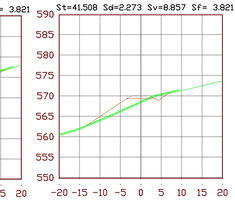
P.K.=940 - Perfil nº 95
Zt=543.165 Zr=547.267 Zsub=546.567
St=89.954 Sd=0.000 Sv=9.143 Sf= 3.821


P.K.=990 - Perfil nº 100
Zt=554.459 Zr=552.267 Zsub=551.567
St=0.000 Sd=67.849 Sv=9.517 Sf= 3.821


P.K.=1040 - Perfil nº 105
Zt=556.766 Zr=557.267 Zsub=556.567
St=10.043 Sd=10.858 Sv=7.354 Sf= 3.821


P.K.=1090 - Perfil nº 110
Zt=560.526 Zr=561.346 Zsub=560.646
St=8.769 Sd=6.143 Sv=5.897 Sf= 3.821


P.K.=1140 - Perfil nº 115
Zt=567.279 Zr=566.346 Zsub=565.646
St=0.000 Sd=32.416 Sv=6.238 Sf= 3.821


P.K.=1190 - Perfil nº 120
Zt=568.573 Zr=570.080 Zsub=569.380
St=41.508 Sd=2.273 Sv=8.857 Sf= 3.821


Zt: Terrain height ; Zr: Grade line height ; Zsub: Subgrade height ; St: Fill surface ; Sd: Cut surface ; Sv: Topsoil surface ; Sf: Base s

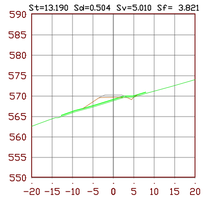
LEGEND

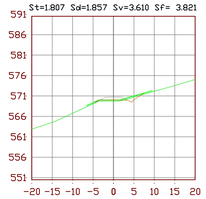
- Terrain
- Topsoil
- Base
- Subgrade and earth-works

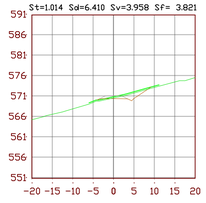
upna

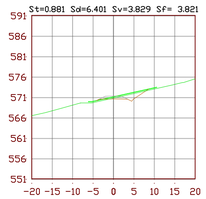
College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

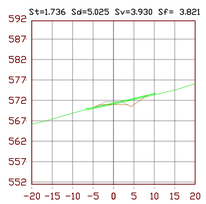
PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_5.2	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road cross-sections on the modified ground II	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 05/04/2020
SCALE: 1/750	Plan number: 5.2	

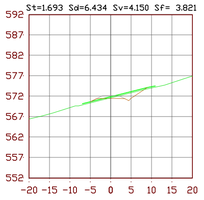
P.K.=1200 - Perfil nº 121
Zt=569.182 Zr=570.403 Zsub=569.703
St=13.190 Sd=0.504 Sv=5.010 Sf= 3.821


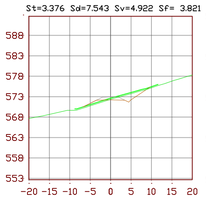
P.K.=1210 - Perfil nº 122
Zt=570.000 Zr=570.725 Zsub=570.025
St=1.807 Sd=1.857 Sv=3.610 Sf= 3.821


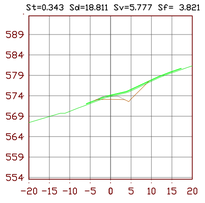
P.K.=1220 - Perfil nº 123
Zt=570.779 Zr=571.048 Zsub=570.348
St=1.014 Sd=6.410 Sv=3.958 Sf= 3.821


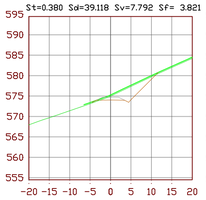
P.K.=1230 - Perfil nº 124
Zt=571.179 Zr=571.371 Zsub=570.671
St=0.881 Sd=6.401 Sv=3.829 Sf= 3.821


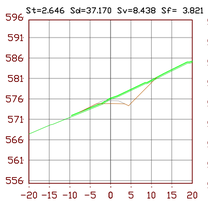
P.K.=1240 - Perfil nº 125
Zt=571.313 Zr=571.694 Zsub=570.994
St=1.736 Sd=5.025 Sv=3.930 Sf= 3.821


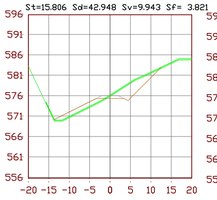
P.K.=1250 - Perfil nº 126
Zt=571.866 Zr=572.146 Zsub=571.446
St=1.693 Sd=6.434 Sv=4.150 Sf= 3.821


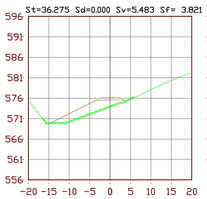
P.K.=1260 - Perfil nº 127
Zt=572.647 Zr=572.919 Zsub=572.219
St=3.376 Sd=7.543 Sv=4.922 Sf= 3.821


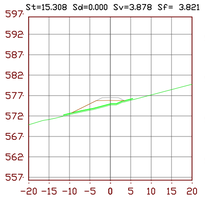
P.K.=1270 - Perfil nº 128
Zt=574.131 Zr=573.820 Zsub=573.120
St=0.343 Sd=18.811 Sv=5.777 Sf= 3.821


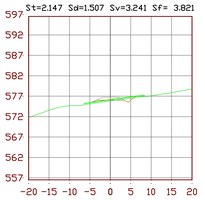
P.K.=1280 - Perfil nº 129
Zt=575.266 Zr=574.722 Zsub=574.022
St=0.380 Sd=39.118 Sv=7.792 Sf= 3.821


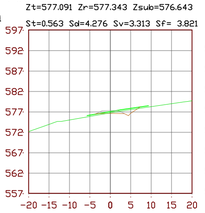
P.K.=1290 - Perfil nº 130
Zt=576.195 Zr=575.569 Zsub=574.869
St=2.646 Sd=37.170 Sv=8.438 Sf= 3.821


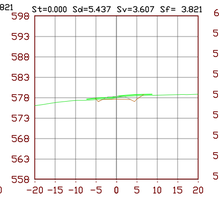
P.K.=1300 - Perfil nº 131
Zt=576.109 Zr=576.039 Zsub=575.339
St=15.806 Sd=42.948 Sv=9.943 Sf= 3.821


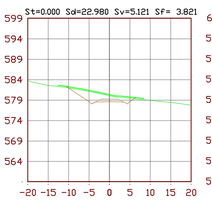
P.K.=1310 - Perfil nº 132
Zt=574.047 Zr=576.281 Zsub=575.581
St=36.275 Sd=0.000 Sv=5.483 Sf= 3.821


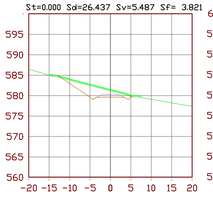
P.K.=1320 - Perfil nº 133
Zt=574.967 Zr=576.523 Zsub=575.823
St=15.308 Sd=0.000 Sv=3.878 Sf= 3.821


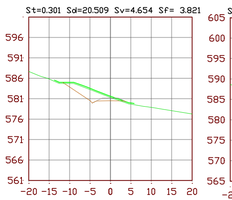
P.K.=1330 - Perfil nº 134
Zt=576.140 Zr=576.767 Zsub=576.067
St=2.147 Sd=1.507 Sv=3.241 Sf= 3.821


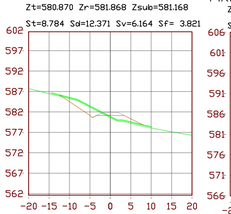
P.K.=1340 - Perfil nº 135
Zt=577.091 Zr=577.343 Zsub=576.643
St=0.563 Sd=4.276 Sv=3.313 Sf= 3.821


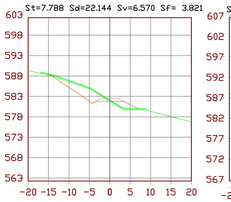
P.K.=1350 - Perfil nº 136
Zt=578.282 Zr=578.325 Zsub=577.625
St=0.000 Sd=5.437 Sv=3.607 Sf= 3.821


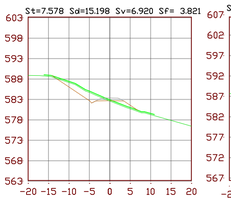
P.K.=1360 - Perfil nº 137
Zt=580.360 Zr=579.325 Zsub=578.625
St=0.000 Sd=22.980 Sv=5.121 Sf= 3.821


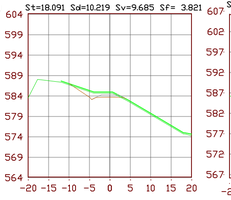
P.K.=1370 - Perfil nº 138
Zt=581.481 Zr=580.325 Zsub=579.625
St=0.000 Sd=26.437 Sv=5.487 Sf= 3.821


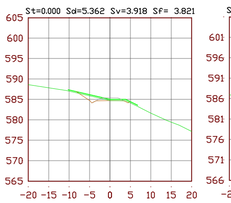
P.K.=1380 - Perfil nº 139
Zt=581.605 Zr=581.207 Zsub=580.507
St=0.301 Sd=20.509 Sv=4.654 Sf= 3.821


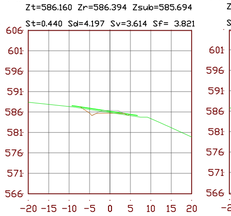
P.K.=1390 - Perfil nº 140
Zt=580.870 Zr=581.868 Zsub=581.168
St=8.784 Sd=12.371 Sv=6.164 Sf= 3.821


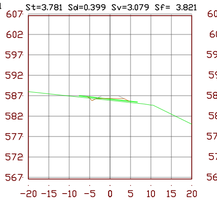
P.K.=1400 - Perfil nº 141
Zt=582.090 Zr=582.522 Zsub=581.822
St=7.788 Sd=22.144 Sv=6.570 Sf= 3.821


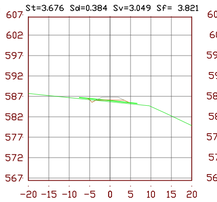
P.K.=1410 - Perfil nº 142
Zt=582.922 Zr=583.395 Zsub=582.695
St=7.578 Sd=15.198 Sv=6.920 Sf= 3.821


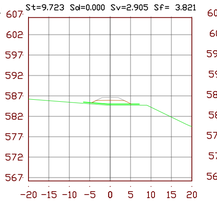
P.K.=1420 - Perfil nº 143
Zt=585.000 Zr=584.394 Zsub=583.694
St=18.091 Sd=10.219 Sv=9.685 Sf= 3.821


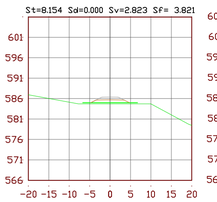
P.K.=1430 - Perfil nº 144
Zt=585.009 Zr=585.394 Zsub=584.694
St=0.000 Sd=5.362 Sv=3.918 Sf= 3.821


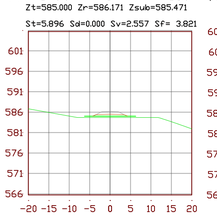
P.K.=1440 - Perfil nº 145
Zt=586.160 Zr=586.394 Zsub=585.694
St=0.440 Sd=4.197 Sv=3.614 Sf= 3.821


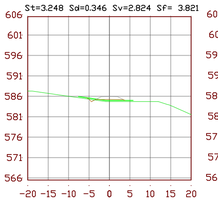
P.K.=1450 - Perfil nº 146
Zt=586.160 Zr=587.045 Zsub=586.345
St=3.781 Sd=0.399 Sv=3.079 Sf= 3.821


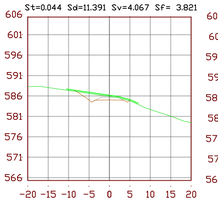
P.K.=1460 - Perfil nº 147
Zt=585.960 Zr=586.837 Zsub=586.137
St=3.676 Sd=0.384 Sv=3.049 Sf= 3.821


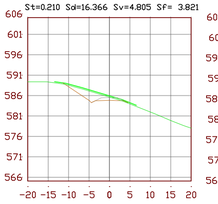
P.K.=1470 - Perfil nº 148
Zt=585.000 Zr=586.615 Zsub=585.915
St=9.723 Sd=0.000 Sv=2.905 Sf= 3.821


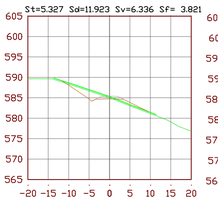
P.K.=1480 - Perfil nº 149
Zt=585.000 Zr=586.393 Zsub=585.693
St=8.154 Sd=0.000 Sv=2.823 Sf= 3.821


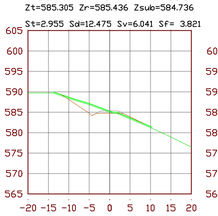
P.K.=1490 - Perfil nº 150
Zt=585.000 Zr=586.171 Zsub=585.471
St=5.896 Sd=0.000 Sv=2.557 Sf= 3.821


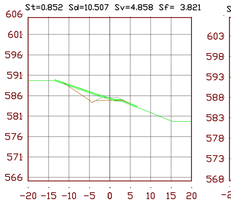
P.K.=1500 - Perfil nº 151
Zt=585.000 Zr=585.949 Zsub=585.249
St=3.248 Sd=0.346 Sv=2.824 Sf= 3.821


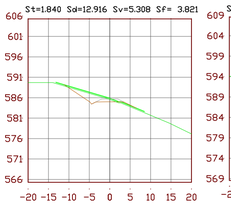
P.K.=1510 - Perfil nº 152
Zt=586.172 Zr=585.727 Zsub=585.027
St=0.044 Sd=11.391 Sv=4.067 Sf= 3.821


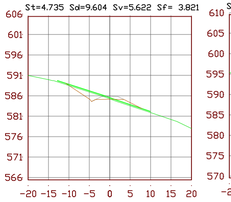
P.K.=1520 - Perfil nº 153
Zt=585.926 Zr=585.515 Zsub=584.815
St=0.210 Sd=16.366 Sv=4.805 Sf= 3.821


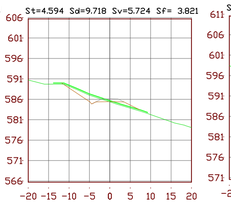
P.K.=1530 - Perfil nº 154
Zt=585.280 Zr=585.410 Zsub=584.710
St=5.327 Sd=11.923 Sv=6.336 Sf= 3.821


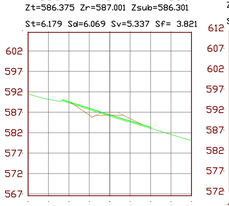
P.K.=1540 - Perfil nº 155
Zt=585.305 Zr=585.436 Zsub=584.736
St=2.955 Sd=12.475 Sv=6.041 Sf= 3.821


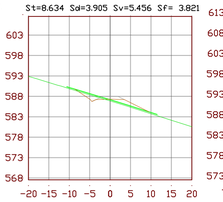
P.K.=1550 - Perfil nº 156
Zt=585.400 Zr=585.570 Zsub=584.870
St=0.852 Sd=10.507 Sv=4.858 Sf= 3.821


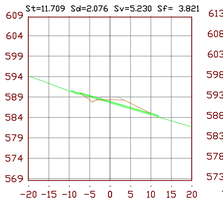
P.K.=1560 - Perfil nº 157
Zt=585.854 Zr=585.714 Zsub=585.014
St=1.840 Sd=12.916 Sv=5.308 Sf= 3.821


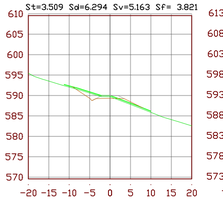
P.K.=1570 - Perfil nº 158
Zt=585.557 Zr=585.857 Zsub=585.157
St=4.735 Sd=9.604 Sv=5.622 Sf= 3.821


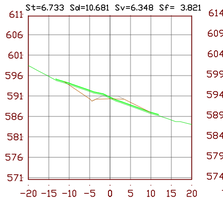
P.K.=1580 - Perfil nº 159
Zt=585.680 Zr=586.128 Zsub=585.428
St=4.594 Sd=9.718 Sv=5.724 Sf= 3.821


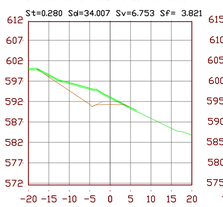
P.K.=1590 - Perfil nº 160
Zt=586.375 Zr=587.001 Zsub=586.301
St=6.179 Sd=6.069 Sv=5.337 Sf= 3.821


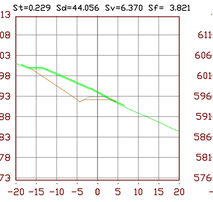
P.K.=1600 - Perfil nº 161
Zt=587.179 Zr=588.001 Zsub=587.301
St=8.634 Sd=3.905 Sv=5.456 Sf= 3.821


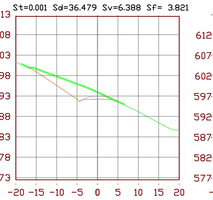
P.K.=1610 - Perfil nº 162
Zt=587.862 Zr=589.001 Zsub=588.301
St=11.709 Sd=2.076 Sv=5.230 Sf= 3.821


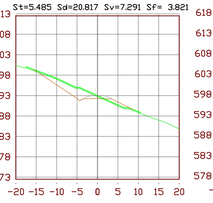
P.K.=1620 - Perfil nº 163
Zt=590.000 Zr=590.001 Zsub=589.301
St=3.509 Sd=6.294 Sv=5.163 Sf= 3.821


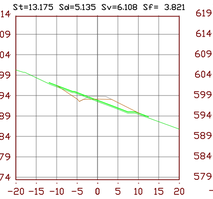
P.K.=1630 - Perfil nº 164
Zt=590.740 Zr=591.001 Zsub=590.301
St=6.733 Sd=10.681 Sv=6.348 Sf= 3.821


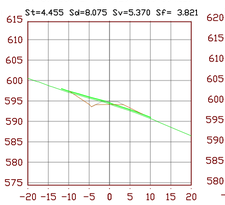
P.K.=1640 - Perfil nº 165
Zt=593.093 Zr=592.001 Zsub=591.301
St=0.280 Sd=34.007 Sv=6.753 Sf= 3.821


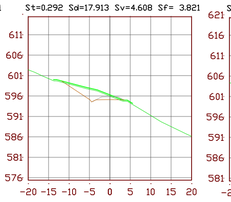
P.K.=1650 - Perfil nº 166
Zt=594.087 Zr=592.875 Zsub=592.175
St=0.229 Sd=44.056 Sv=6.370 Sf= 3.821


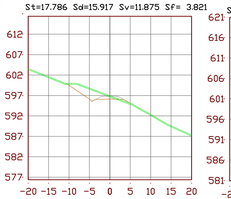
P.K.=1660 - Perfil nº 167
Zt=594.015 Zr=592.915 Zsub=592.215
St=0.001 Sd=36.479 Sv=6.388 Sf= 3.821


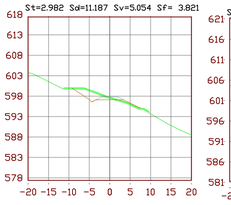
P.K.=1670 - Perfil nº 168
Zt=592.999 Zr=592.955 Zsub=592.255
St=5.485 Sd=20.817 Sv=7.291 Sf= 3.821


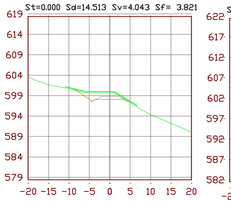
P.K.=1680 - Perfil nº 169
Zt=592.822 Zr=593.829 Zsub=593.129
St=13.175 Sd=5.135 Sv=6.108 Sf= 3.821


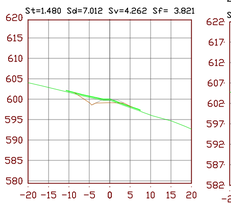
P.K.=1690 - Perfil nº 170
Zt=594.538 Zr=594.829 Zsub=594.129
St=4.455 Sd=8.075 Sv=5.370 Sf= 3.821


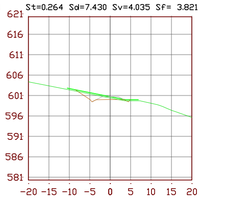
P.K.=1700 - Perfil nº 171
Zt=596.286 Zr=595.829 Zsub=595.129
St=0.292 Sd=17.913 Sv=4.608 Sf= 3.821


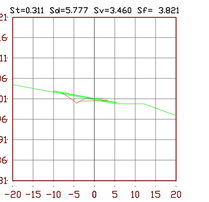
P.K.=1710 - Perfil nº 172
Zt=596.955 Zr=596.829 Zsub=596.129
St=17.786 Sd=15.917 Sv=11.875 Sf= 3.821


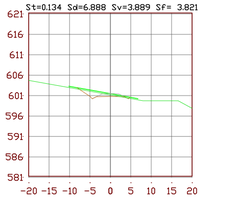
P.K.=1720 - Perfil nº 173
Zt=597.711 Zr=597.829 Zsub=597.129
St=2.982 Sd=11.187 Sv=5.054 Sf= 3.821


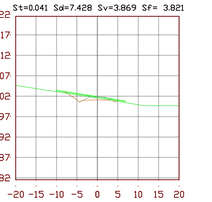
P.K.=1730 - Perfil nº 174
Zt=600.000 Zr=598.829 Zsub=598.129
St=0.000 Sd=14.513 Sv=4.043 Sf= 3.821


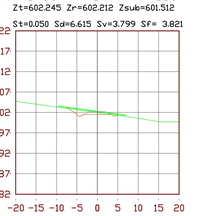
P.K.=1740 - Perfil nº 175
Zt=600.000 Zr=599.829 Zsub=599.129
St=1.480 Sd=7.012 Sv=4.262 Sf= 3.821


P.K.=1750 - Perfil nº 176
Zt=600.717 Zr=600.732 Zsub=600.032
St=0.264 Sd=7.430 Sv=4.035 Sf= 3.821


P.K.=1760 - Perfil nº 177
Zt=601.049 Zr=601.192 Zsub=600.492
St=0.311 Sd=5.777 Sv=3.460 Sf= 3.821


P.K.=1770 - Perfil nº 178
Zt=601.476 Zr=601.490 Zsub=600.790
St=0.134 Sd=6.888 Sv=3.889 Sf= 3.821


P.K.=1780 - Perfil nº 179
Zt=601.870 Zr=601.787 Zsub=601.087
St=0.041 Sd=7.428 Sv=3.869 Sf= 3.821


P.K.=1790 - Perfil nº 180
Zt=602.245 Zr=602.212 Zsub=601.512
St=0.050 Sd=6.615 Sv=3.799 Sf= 3.821


Zt: Terrain height ; Zr: Grade line height ; Zsub: Subgrade height ; St: Fill surface ; Sd: Cut surface ; Sv: Topsoil surface ; Sf: Base s

LEGEND

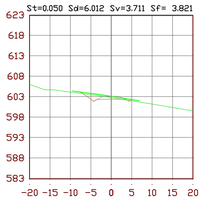
- Terrain
- Topsoil
- Base
- Subgrade and earth-works

upna

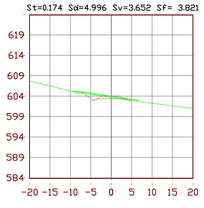
College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_5.3	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road cross-sections on the modified ground III	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 05/04/2020
SCALE: 1/750	Plan number: 5.3	

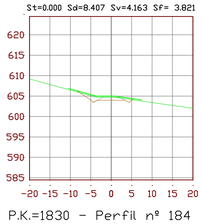
P.K.=1800 - Perfil nº 181
Zt=603.063 Zr=603.088 Zsub=602.388
St=0.050 Sd=6.012 Sv=3.711 Sf= 3.821



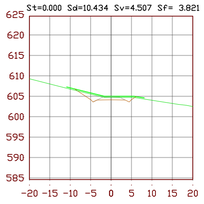
P.K.=1810 - Perfil nº 182
Zt=603.955 Zr=604.091 Zsub=603.391
St=0.174 Sd=4.996 Sv=3.652 Sf= 3.821



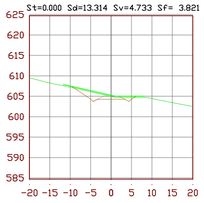
P.K.=1820 - Perfil nº 183
Zt=605.000 Zr=604.714 Zsub=604.014
St=0.000 Sd=8.407 Sv=4.163 Sf= 3.821



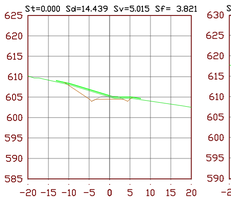
P.K.=1830 - Perfil nº 184
Zt=605.000 Zr=604.846 Zsub=604.146
St=0.000 Sd=10.434 Sv=4.507 Sf= 3.821



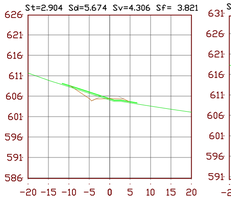
P.K.=1840 - Perfil nº 185
Zt=605.239 Zr=604.969 Zsub=604.269
St=0.000 Sd=13.314 Sv=4.733 Sf= 3.821



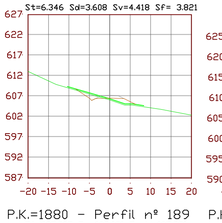
P.K.=1850 - Perfil nº 186
Zt=605.364 Zr=605.218 Zsub=604.518
St=0.000 Sd=14.439 Sv=5.015 Sf= 3.821



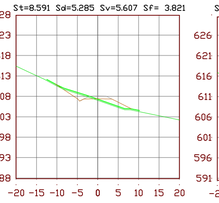
P.K.=1860 - Perfil nº 187
Zt=605.366 Zr=606.091 Zsub=605.391
St=2.904 Sd=5.674 Sv=4.306 Sf= 3.821



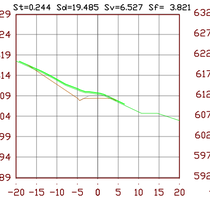
P.K.=1870 - Perfil nº 188
Zt=606.257 Zr=607.091 Zsub=606.391
St=6.346 Sd=3.608 Sv=4.418 Sf= 3.821



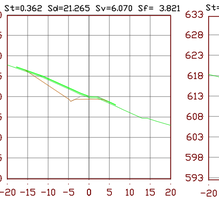
P.K.=1880 - Perfil nº 189
Zt=607.307 Zr=608.091 Zsub=607.391
St=8.591 Sd=5.285 Sv=5.607 Sf= 3.821



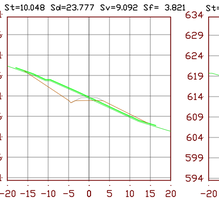
P.K.=1890 - Perfil nº 190
Zt=609.674 Zr=609.091 Zsub=608.391
St=0.244 Sd=19.485 Sv=6.527 Sf= 3.821



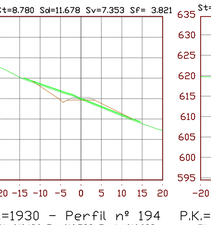
P.K.=1900 - Perfil nº 191
Zt=610.081 Zr=610.091 Zsub=609.391
St=0.362 Sd=21.265 Sv=6.070 Sf= 3.821



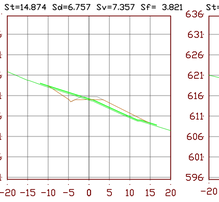
P.K.=1910 - Perfil nº 192
Zt=610.714 Zr=610.582 Zsub=609.882
St=10.048 Sd=23.777 Sv=9.092 Sf= 3.821



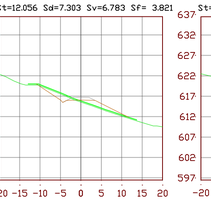
P.K.=1920 - Perfil nº 193
Zt=610.000 Zr=610.353 Zsub=609.653
St=8.780 Sd=11.678 Sv=7.353 Sf= 3.821



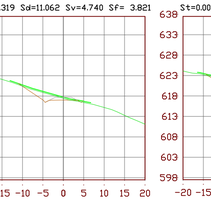
P.K.=1930 - Perfil nº 194
Zt=610.186 Zr=610.729 Zsub=610.029
St=14.874 Sd=6.757 Sv=7.357 Sf= 3.821



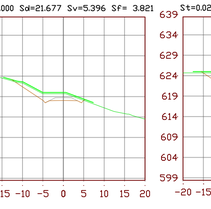
P.K.=1940 - Perfil nº 195
Zt=610.838 Zr=611.729 Zsub=611.029
St=12.056 Sd=7.303 Sv=6.783 Sf= 3.821



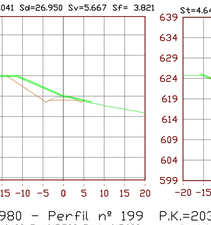
P.K.=1950 - Perfil nº 196
Zt=612.757 Zr=612.729 Zsub=612.029
St=0.319 Sd=11.062 Sv=4.740 Sf= 3.821



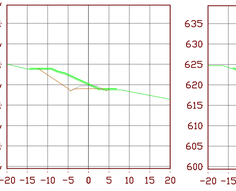
P.K.=1960 - Perfil nº 197
Zt=615.000 Zr=613.729 Zsub=613.029
St=0.000 Sd=21.677 Sv=5.396 Sf= 3.821



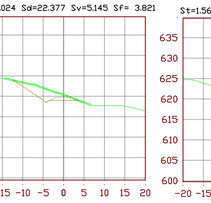
P.K.=1970 - Perfil nº 198
Zt=615.081 Zr=614.729 Zsub=614.029
St=0.041 Sd=26.950 Sv=5.667 Sf= 3.821



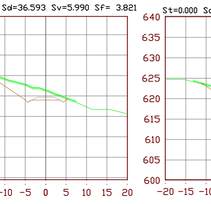
P.K.=1980 - Perfil nº 199
Zt=616.199 Zr=615.729 Zsub=615.029
St=0.427 Sd=24.612 Sv=5.201 Sf= 3.821



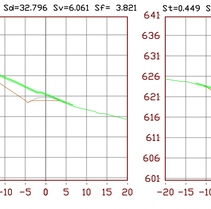
P.K.=1990 - Perfil nº 200
Zt=617.481 Zr=616.729 Zsub=616.029
St=0.024 Sd=22.377 Sv=5.145 Sf= 3.821



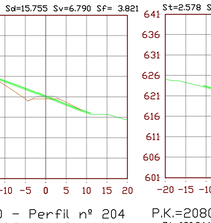
P.K.=2000 - Perfil nº 201
Zt=619.476 Zr=617.729 Zsub=617.029
St=0.000 Sd=36.593 Sv=5.990 Sf= 3.821



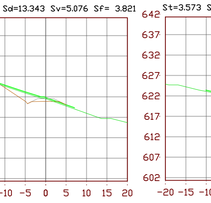
P.K.=2010 - Perfil nº 202
Zt=619.544 Zr=618.646 Zsub=617.946
St=0.022 Sd=32.796 Sv=6.061 Sf= 3.821



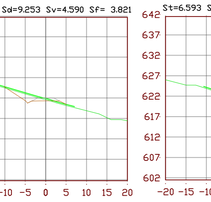
P.K.=2020 - Perfil nº 203
Zt=619.209 Zr=619.220 Zsub=618.520
St=4.642 Sd=15.755 Sv=6.790 Sf= 3.821



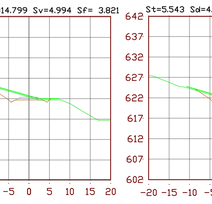
P.K.=2030 - Perfil nº 204
Zt=619.842 Zr=619.613 Zsub=618.913
St=1.086 Sd=13.343 Sv=5.076 Sf= 3.821



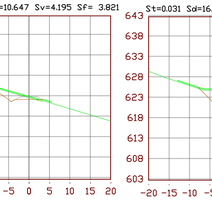
P.K.=2040 - Perfil nº 205
Zt=619.952 Zr=620.006 Zsub=619.306
St=1.561 Sd=9.253 Sv=4.590 Sf= 3.821



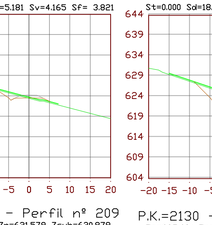
P.K.=2050 - Perfil nº 206
Zt=620.706 Zr=620.400 Zsub=619.700
St=0.000 Sd=14.799 Sv=4.994 Sf= 3.821



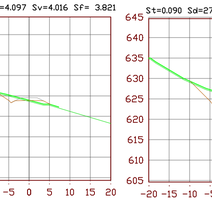
P.K.=2060 - Perfil nº 207
Zt=620.794 Zr=620.793 Zsub=620.093
St=0.449 Sd=10.647 Sv=4.195 Sf= 3.821



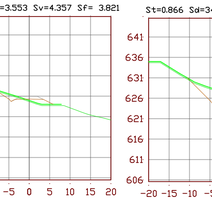
P.K.=2070 - Perfil nº 208
Zt=620.688 Zr=621.186 Zsub=620.486
St=2.578 Sd=5.181 Sv=4.165 Sf= 3.821



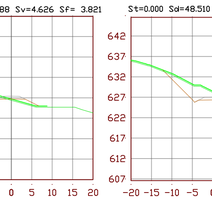
P.K.=2080 - Perfil nº 209
Zt=620.944 Zr=621.579 Zsub=620.879
St=3.573 Sd=4.097 Sv=4.016 Sf= 3.821



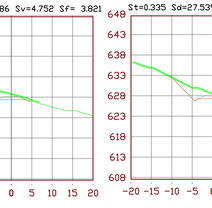
P.K.=2090 - Perfil nº 210
Zt=620.963 Zr=621.972 Zsub=621.272
St=6.593 Sd=3.553 Sv=4.357 Sf= 3.821



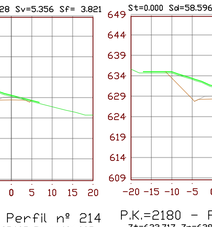
P.K.=2100 - Perfil nº 211
Zt=621.702 Zr=622.413 Zsub=621.713
St=5.543 Sd=4.288 Sv=4.626 Sf= 3.821



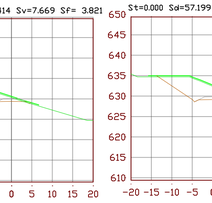
P.K.=2110 - Perfil nº 212
Zt=623.875 Zr=623.150 Zsub=622.450
St=0.031 Sd=16.586 Sv=4.752 Sf= 3.821



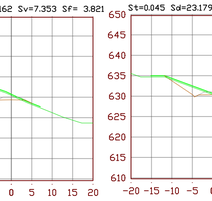
P.K.=2120 - Perfil nº 213
Zt=624.561 Zr=624.119 Zsub=623.419
St=0.000 Sd=18.428 Sv=5.356 Sf= 3.821



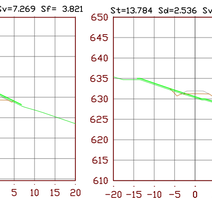
P.K.=2130 - Perfil nº 214
Zt=625.631 Zr=625.095 Zsub=624.395
St=0.090 Sd=27.414 Sv=7.669 Sf= 3.821



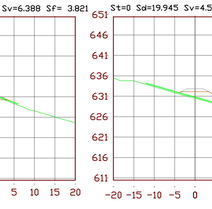
P.K.=2140 - Perfil nº 215
Zt=626.748 Zr=626.071 Zsub=625.371
St=0.866 Sd=34.162 Sv=7.353 Sf= 3.821



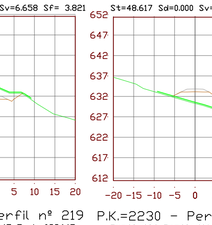
P.K.=2150 - Perfil nº 216
Zt=628.498 Zr=627.046 Zsub=626.346
St=0.000 Sd=48.510 Sv=7.269 Sf= 3.821



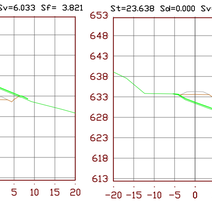
P.K.=2160 - Perfil nº 217
Zt=628.562 Zr=628.022 Zsub=627.322
St=0.335 Sd=27.539 Sv=6.388 Sf= 3.821



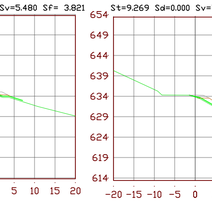
P.K.=2170 - Perfil nº 218
Zt=631.569 Zr=628.998 Zsub=628.298
St=0.000 Sd=58.596 Sv=6.658 Sf= 3.821



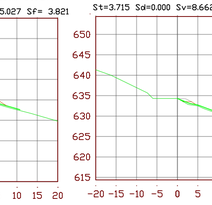
P.K.=2180 - Perfil nº 219
Zt=632.717 Zr=629.847 Zsub=629.147
St=0.000 Sd=57.199 Sv=6.033 Sf= 3.821



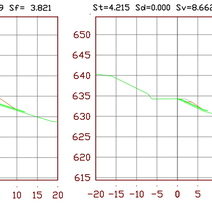
P.K.=2190 - Perfil nº 220
Zt=630.691 Zr=630.901 Zsub=630.201
St=0.045 Sd=23.179 Sv=5.480 Sf= 3.821



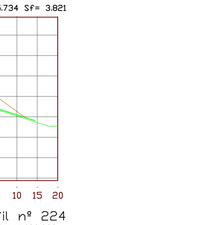
P.K.=2200 - Perfil nº 221
Zt=630.543 Zr=631.970 Zsub=631.270
St=13.784 Sd=2.536 Sv=5.027 Sf= 3.821



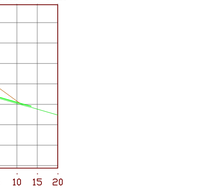
P.K.=2210 - Perfil nº 222
Zt=630.783 Zr=632.863 Zsub=632.163
St=0 Sd=19.945 Sv=4.569 Sf= 3.821



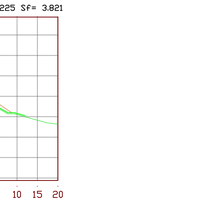
P.K.=2220 - Perfil nº 223
Zt=630.572 Zr=633.822 Zsub=633.122
St=48.617 Sd=0.000 Sv=5.734 Sf= 3.821



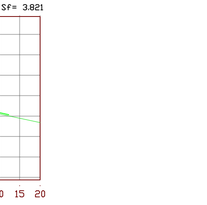
P.K.=2230 - Perfil nº 224
Zt=631.686 Zr=634.000 Zsub=633.333
St=23.638 Sd=0.000 Sv=6.002 Sf= 3.821



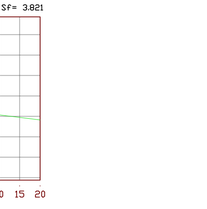
P.K.=2240 - Perfil nº 225
Zt=632.246 Zr=634.274 Zsub=633.574
St=9.269 Sd=0.000 Sv=7.225 Sf= 3.821



P.K.=2250 - Perfil nº 226
Zt=634.274 Zr=634.274 Zsub=633.574
St=3.715 Sd=0.000 Sv=8.662 Sf= 3.821



P.K.=2254,562 - Perfil nº 227
Zt=634.274 Zr=634.274 Zsub=633.574
St=4.215 Sd=0.000 Sv=8.662 Sf= 3.821



Zt: Terrain height ; Zr: Grade line height ; Zsub: Subgrade height ; St: Fill surface ; Sd: Cut surface ; Sv: Topsoil surface ; Sf: Base s

LEGEND

- Terrain
- Topsoil
- Base
- Subgrade and earth-works

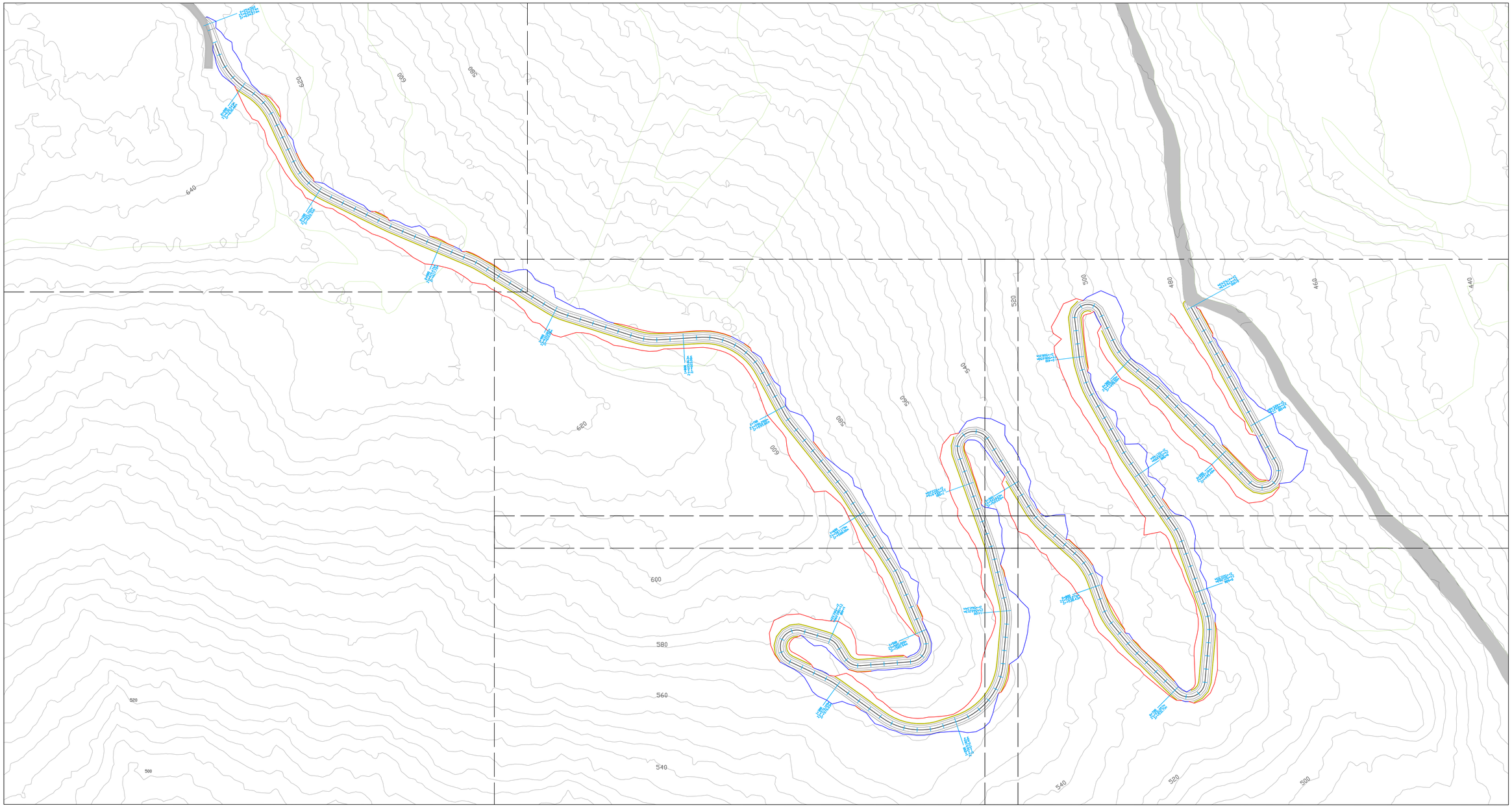
upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_5.4	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Country road cross-sections on the modified ground IV	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 05/04/2020
SCALE: 1/750	Plan number: 5.4	

C B A

I II III



LEGEND

- Axis
- Dimensioning
- Cuts
- Fills
- Gutter system
- Base
- Pre-existing country roads
- Contour lines
- Land registry

The cut slope will be 3/2 for the entire country road except for the following sections:

- -Section between PK 0+149 and PK 0+200: 1/1 slope (+10 m of transition after that)
- -Section between PK 0+962.5 and PK 1+010: 1/1 slope (+10 m of transition after that)
- -Section between PK 1+270 and PK 1+300: 1/1 slope (+10 m of transition before that)
- -Section between PK 2+110 and PK 2+170: 1/1 slope (+10 m of transition before and after that)

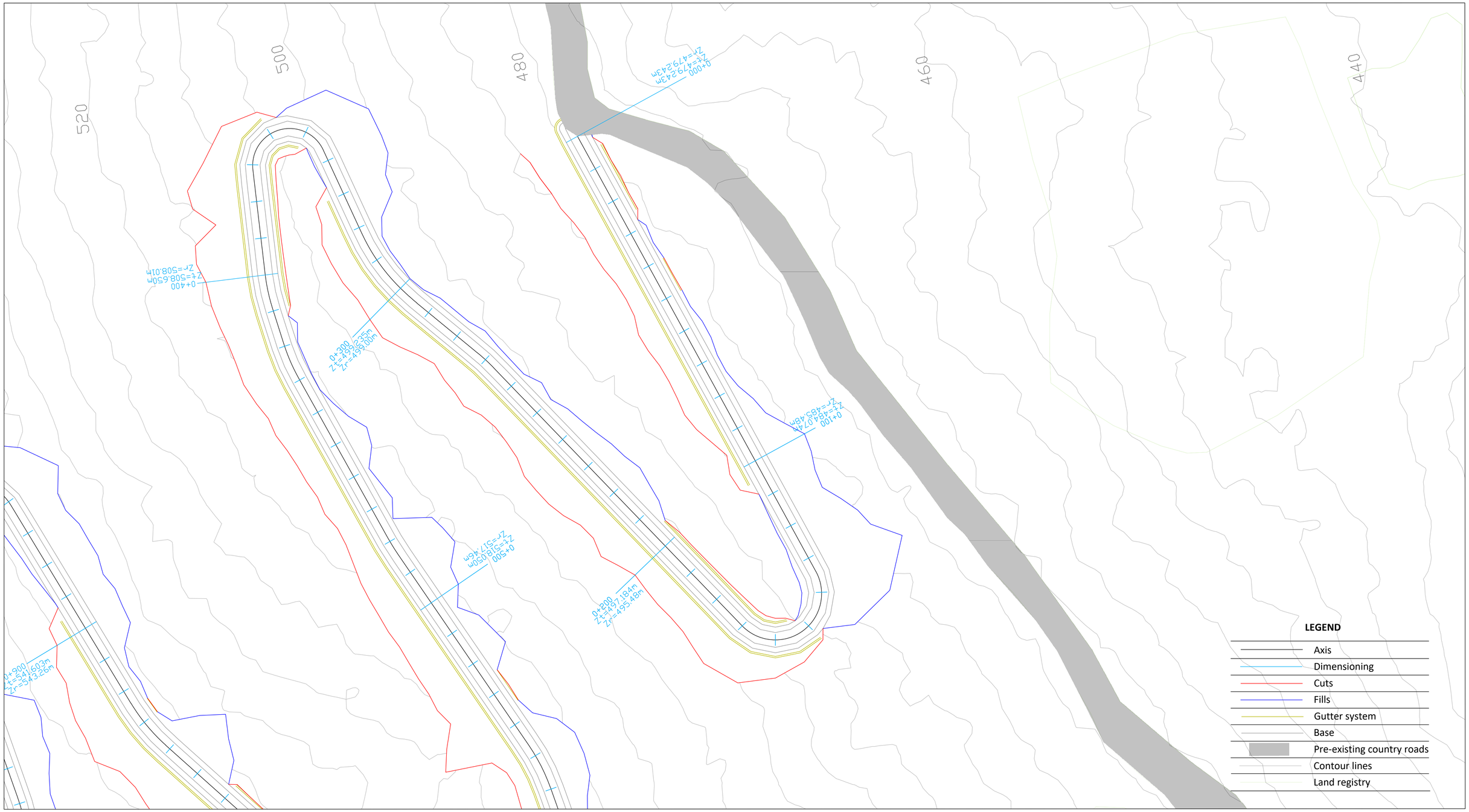
The fill slope will be 2/1 for the entire country road except for the following sections:

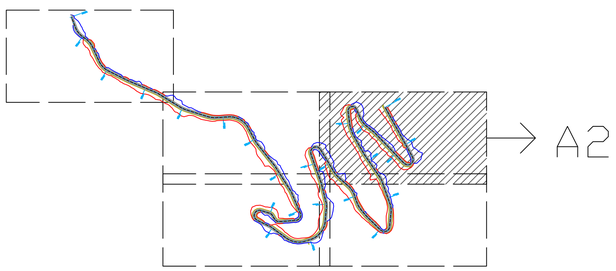
- -Section between PK 0+535 and PK 0+625: 3/2 slope
- -Section between PK 0+890 and PK 0+960: 3/2 slope (+10 m of transition before that)
- -Section between PK 1+165 and PK 1+200: 3/2 slope (+10 m of transition after that)
- -Section between PK 1+410 and PK 1+425: 3/2 slope
- -Section between PK 1+665 and PK 1+725: 3/2 slope
- -Section between PK 2+180 and PK final: 3/2 slope (only for the right fill)

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_6	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Earthworks. Master Plan	
Technical reference: Asier Gamallo Valls Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 27/03/2020	SCALE: 1/1500 Plan number: 6





The cut slope will be 3/2 for the entire country road except for the following sections:

- -Section between PK 0+149 and PK 0+200: 1/1 slope (+10 m of transition after that)
- -Section between PK 0+962.5 and PK 1+010: 1/1 slope (+10 m of transition after that)
- -Section between PK 1+270 and PK 1+300: 1/1 slope (+10 m of transition before that)
- -Section between PK 2+110 and PK 2+170: 1/1 slope (+10 m of transition before and after that)

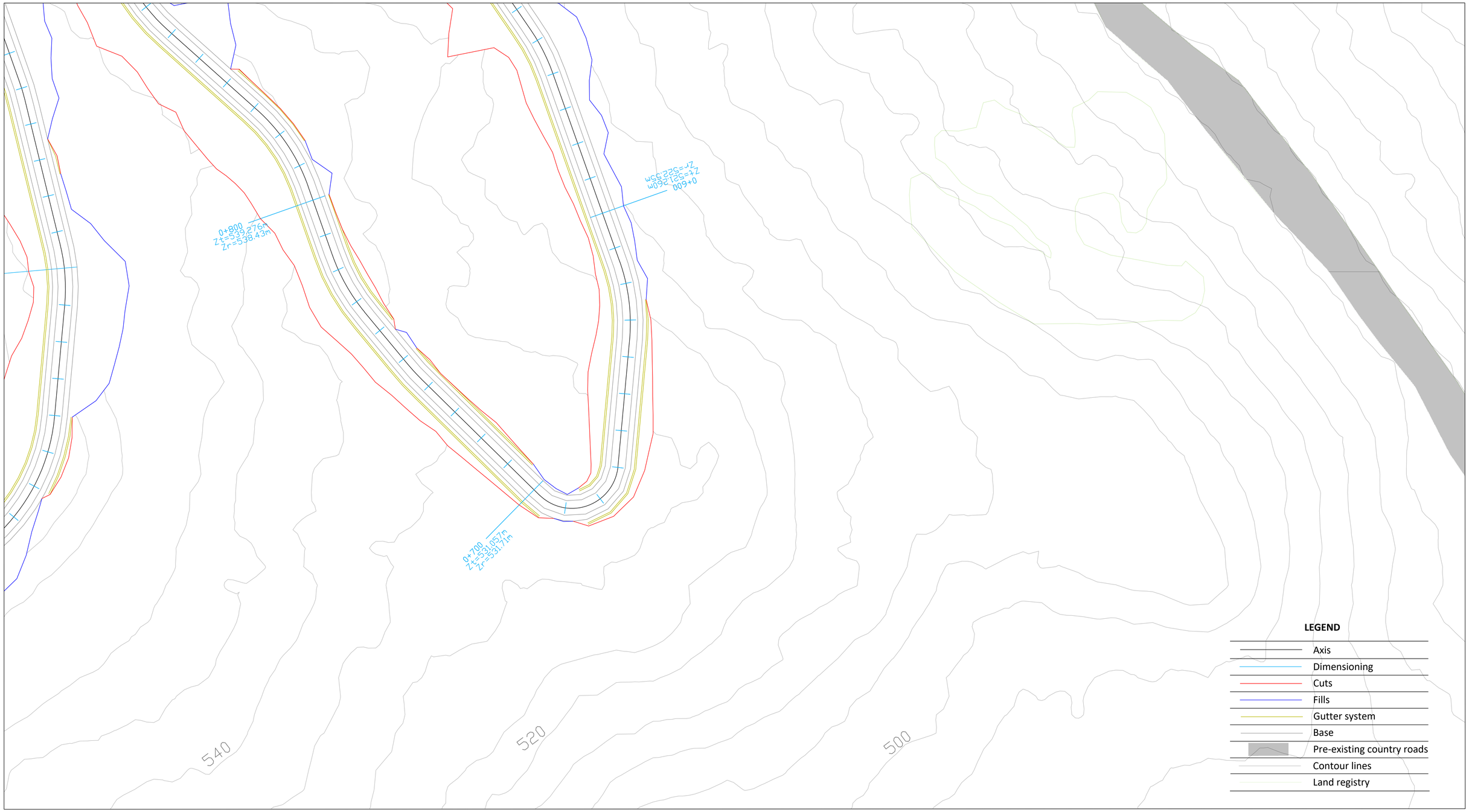
The fill slope will be 2/1 for the entire country road except for the following sections:

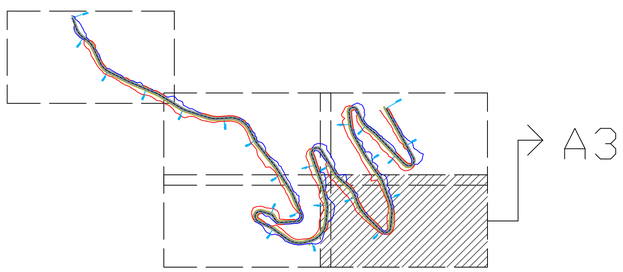
- -Section between PK 0+535 and PK 0+625: 3/2 slope
- -Section between PK 0+890 and PK 0+960: 3/2 slope (+10 m of transition before that)
- -Section between PK 1+165 and PK 1+200: 3/2 slope (+10 m of transition after that)
- -Section between PK 1+410 and PK 1+425: 3/2 slope
- -Section between PK 1+665 and PK 1+725: 3/2 slope
- -Section between PK 2+180 and PK final: 3/2 slope (only for the right fill)

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_6.1	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Earthworks. AII area plan	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020
SCALE: 1/500	Plan number: 6.1	





The cut slope will be 3/2 for the entire country road except for the following sections:

- -Section between PK 0+149 and PK 0+200: 1/1 slope (+10 m of transition after that)
- -Section between PK 0+962.5 and PK 1+010: 1/1 slope (+10 m of transition after that)
- -Section between PK 1+270 and PK 1+300: 1/1 slope (+10 m of transition before that)
- -Section between PK 2+110 and PK 2+170: 1/1 slope (+10 m of transition before and after that)

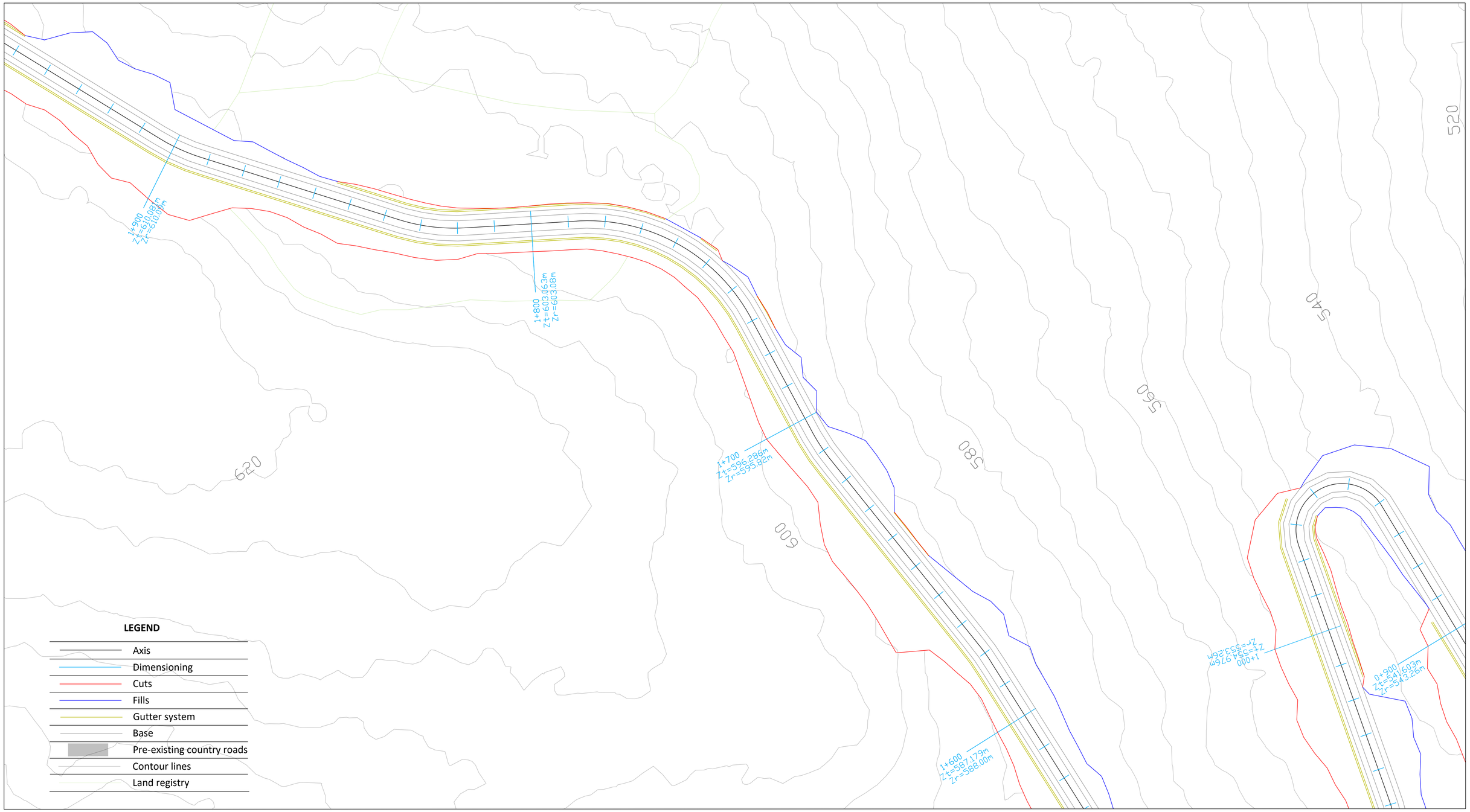
The fill slope will be 2/1 for the entire country road except for the following sections:

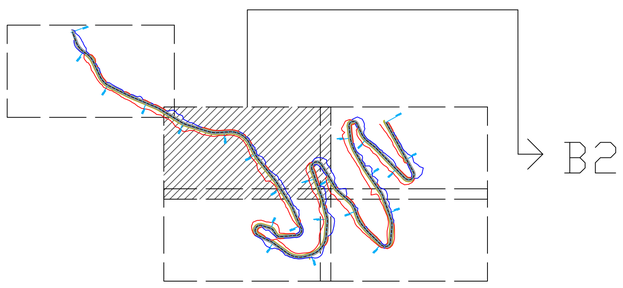
- -Section between PK 0+535 and PK 0+625: 3/2 slope
- -Section between PK 0+890 and PK 0+960: 3/2 slope (+10 m of transition before that)
- -Section between PK 1+165 and PK 1+200: 3/2 slope (+10 m of transition after that)
- -Section between PK 1+410 and PK 1+425: 3/2 slope
- -Section between PK 1+665 and PK 1+725: 3/2 slope
- -Section between PK 2+180 and PK final: 3/2 slope (only for the right fill)

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_6.2	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Earthworks. AIII area plan	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020
SCALE: 1/500	Plan number: 6.2	





The cut slope will be 3/2 for the entire country road except for the following sections:

- -Section between PK 0+149 and PK 0+200: 1/1 slope (+10 m of transition after that)
- -Section between PK 0+962.5 and PK 1+010: 1/1 slope (+10 m of transition after that)
- -Section between PK 1+270 and PK 1+300: 1/1 slope (+10 m of transition before that)
- -Section between PK 2+110 and PK 2+170: 1/1 slope (+10 m of transition before and after that)

The fill slope will be 2/1 for the entire country road except for the following sections:

- -Section between PK 0+535 and PK 0+625: 3/2 slope
- -Section between PK 0+890 and PK 0+960: 3/2 slope (+10 m of transition before that)
- -Section between PK 1+165 and PK 1+200: 3/2 slope (+10 m of transition after that)
- -Section between PK 1+410 and PK 1+425: 3/2 slope
- -Section between PK 1+665 and PK 1+725: 3/2 slope
- -Section between PK 2+180 and PK final: 3/2 slope (only for the right fill)

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_6.3	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Earthworks. BII area plan	
Technical reference: Asier Gamallo Valls / Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020	SCALE: 1/500 — Plan number: 6.3

600

580

560

540

1+600
Zt=587.179m
Zr=588.00m

1+400
Zt=582.090m
Zr=583.52m

1+500
Zt=585.000m
Zr=585.94m

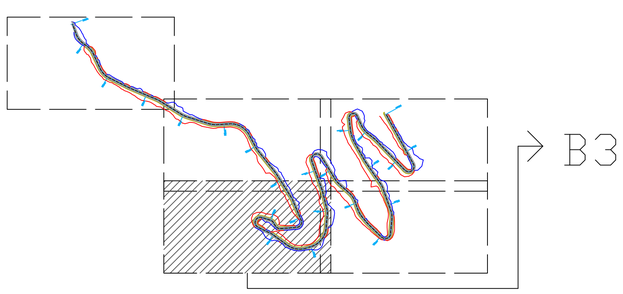
1+100
Zt=560.213m
Zr=562.34m

1+300
Zt=575.109m
Zr=576.03m

1+200
Zt=569.182m
Zr=570.40m

LEGEND

- Axis
- Dimensioning
- Cuts
- Fills
- Gutter system
- Base
- Pre-existing country roads
- Contour lines
- Land registry



The cut slope will be 3/2 for the entire country road except for the following sections:

- -Section between PK 0+149 and PK 0+200: 1/1 slope (+10 m of transition after that)
- -Section between PK 0+962.5 and PK 1+010: 1/1 slope (+10 m of transition after that)
- -Section between PK 1+270 and PK 1+300: 1/1 slope (+10 m of transition before that)
- -Section between PK 2+110 and PK 2+170: 1/1 slope (+10 m of transition before and after that)

The fill slope will be 2/1 for the entire country road except for the following sections:

- -Section between PK 0+535 and PK 0+625: 3/2 slope
- -Section between PK 0+890 and PK 0+960: 3/2 slope (+10 m of transition before that)
- -Section between PK 1+165 and PK 1+200: 3/2 slope (+10 m of transition after that)
- -Section between PK 1+410 and PK 1+425: 3/2 slope
- -Section between PK 1+665 and PK 1+725: 3/2 slope
- -Section between PK 2+180 and PK final: 3/2 slope (only for the right fill)

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_6.4	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Earthworks. BIII area plan	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020
SCALE: 1/500	Plan number: 6.4	

2+254.562
Zt=634.274m
Zr=634.274m

2+200
Zt=630.543m
Zr=630.46m

2+100
Zt=621.702m
Zr=622.41m

2+000
Zt=619.476m
Zr=617.72m

620

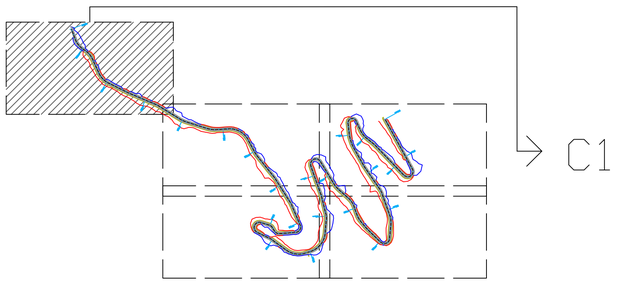
600

580

640

LEGEND

- Axis
- Dimensioning
- Cuts
- Fills
- Gutter system
- Base
- Pre-existing country roads
- Contour lines
- Land registry



The cut slope will be 3/2 for the entire country road except for the following sections:

- -Section between PK 0+149 and PK 0+200: 1/1 slope (+10 m of transition after that)
- -Section between PK 0+962.5 and PK 1+010: 1/1 slope (+10 m of transition after that)
- -Section between PK 1+270 and PK 1+300: 1/1 slope (+10 m of transition before that)
- -Section between PK 2+110 and PK 2+170: 1/1 slope (+10 m of transition before and after that)

The fill slope will be 2/1 for the entire country road except for the following sections:

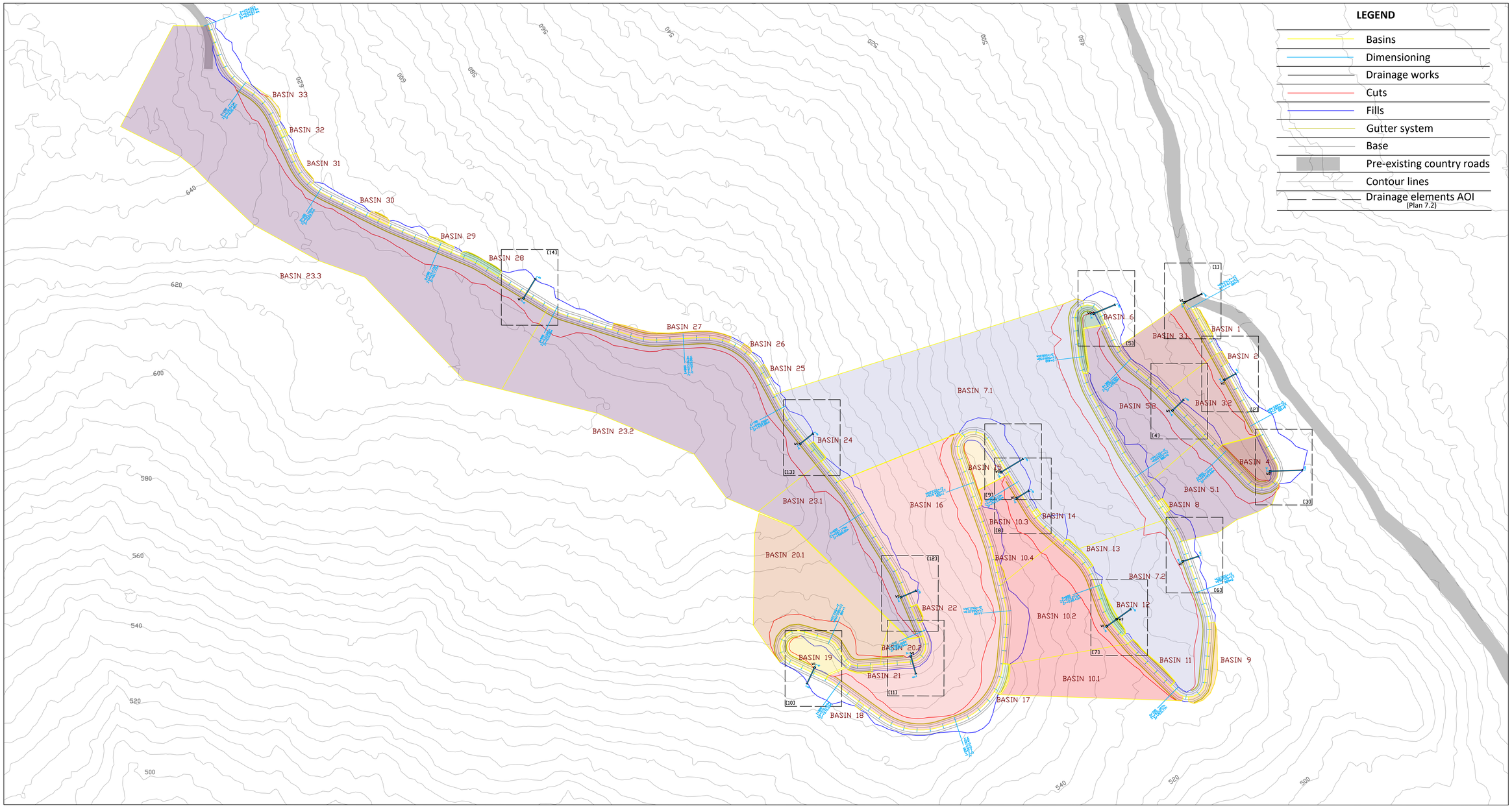
- -Section between PK 0+535 and PK 0+625: 3/2 slope
- -Section between PK 0+890 and PK 0+960: 3/2 slope (+10 m of transition before that)
- -Section between PK 1+165 and PK 1+200: 3/2 slope (+10 m of transition after that)
- -Section between PK 1+410 and PK 1+425: 3/2 slope
- -Section between PK 1+665 and PK 1+725: 3/2 slope
- -Section between PK 2+180 and PK final: 3/2 slope (only for the right fill)

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_6.5	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Earthworks. CI area plan	

Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 13/03/2020 Edited (present): 26/03/2020	SCALE: 1/500	Plan number: 6.5



		J (m/m)	L (km)	S (km2)	Tc (h)	Q (m3/s)	Q´(m3/s)	Discharges in…	Qtotal (m3/s)
	BASIN 1	0,08	0,02616	0,00012	0,03345	0,00046	0,00056	-	0,00056
	BASIN 2	0,08	0,01445	0,00005	0,02130	0,00018	0,00022	-	0,00022
	BASIN 3.1	0,08	0,083	0,00251	0,08043	0,00972	0,01166	-	0,01166
	BASIN 3.2	0,08	0,089	0,00258	0,08481	0,01001	0,01202	-	0,03475
	BASIN 4	0,08	0,05014	0,00107	0,05484	0,00415	0,00498	-	0,00498
	BASIN 5.1	0,08	0,126	0,00405	0,11046	0,01570	0,01885	-	0,01906
	BASIN 5.2	0,08	0,122	0,00489	0,10779	0,01895	0,02274	3.2	0,02274
	BASIN 6	0,08	0,05189	0,00043	0,05628	0,00165	0,00199	-	0,00199
	BASIN 7.1	0,08	0,248	0,02495	0,18480	0,09669	0,11603	-	0,40060
	BASIN 7.2	0,08	0,141	0,00723	0,12032	0,02802	0,03363	-	0,02838
	BASIN 8	0,08	0,0144	0,00005	0,02125	0,00018	0,00021	5.1	0,00021
	BASIN 9	0,08	0,07166	0,00045	0,07193	0,00174	0,00209	-	0,00209
	BASIN 10.1	0,08	0,014	0,00380	0,02080	0,01472	0,01767	-	0,01823
	BASIN 10.2	0,08	0,14	0,00552	0,11967	0,02141	0,02569	7.2	0,02569
	BASIN 10.3	0,08	0,079	0,00258	0,07747	0,00998	0,01198	7.1	0,01218
	BASIN 10.4	0,08	0,01063	0,00004	0,01687	0,00017	0,00020	10.3	0,00020
	BASIN 11	0,08	0,04894	0,00023	0,05384	0,00088	0,00106	7.2	0,00106
	BASIN 12	0,08	0,0425	0,00022	0,04836	0,00086	0,00104	7.2	0,00104
	BASIN 13	0,08	0,03052	0,00013	0,03760	0,00049	0,00059	7.2	0,00059
	BASIN 14	0,08	0,00856	0,00002	0,01431	0,00008	0,00010	7.1	0,00010
	BASIN 15	0,08	0,05013	0,00110	0,05483	0,00427	0,00513	7.1	0,00513

		J (m/m)	L (km)	S (km2)	Tc (h)	Q (m3/s)	Q´(m3/s)	Discharges in…	Qtotal (m3/s)
	BASIN 16	0,08	0,34493	0,01694	0,23747	0,06567	0,07880	7.1	0,18829
	BASIN 17	0,08	0,02614	0,00012	0,03343	0,00047	0,00056	10.1	0,00056
	BASIN 18	0,08	0,0094	0,00002	0,01536	0,00009	0,00010	-	0,00010
	BASIN 19	0,08	0,04088	0,00116	0,04695	0,00451	0,00542	-	0,00542
	BASIN 20.1	0,08	0,11324	0,00672	0,10185	0,02603	0,03124	-	0,03124
	BASIN 20.2	0,08	0,03	0,00068	0,03711	0,00264	0,00317	16	0,00317
	BASIN 21	0,08	0,0215	0,00008	0,02881	0,00030	0,00036	16	0,00036
	BASIN 22	0,08	0,01541	0,00006	0,02237	0,00024	0,00028	16	0,00028
	BASIN 23.1	0,08	0,20502	0,00522	0,15992	0,02024	0,02429	-	0,02429
	BASIN 23.2	0,08	0,32015	0,01689	0,22439	0,06546	0,07856	7.1	0,07856
	BASIN 23.3	0,08	0,37375	0,02272	0,25240	0,08807	0,10569	16	0,10569
	BASIN 24	0,08	0,01928	0,00007	0,02652	0,00026	0,00032	7.1	0,00032
	BASIN 25	0,08	0,01478	0,00005	0,02167	0,00018	0,00021	-	0,00021
	BASIN 26	0,08	0,01027	0,00004	0,01643	0,00015	0,00017	-	0,00017
	BASIN 27	0,08	0,0946	0,00047	0,08884	0,00182	0,00218	-	0,00218
	BASIN 28	0,08	0,0347	0,00016	0,04146	0,00064	0,00076	-	0,00076
	BASIN 29	0,08	0,02404	0,00010	0,03136	0,00039	0,00047	-	0,00047
	BASIN 30	0,08	0,01502	0,00007	0,02194	0,00029	0,00035	-	0,00035
	BASIN 31	0,08	0,02801	0,00012	0,03523	0,00048	0,00058	-	0,00058
	BASIN 32	0,08	0,00925	0,00002	0,01518	0,00009	0,00011	-	0,00011
	BASIN 33	0,08	0,04282	0,00023	0,04864	0,00087	0,00105	-	0,00105

J=Main channel average slope
L=Main channel length
S=Basin's surface
Tc=Concentration time
Q=Flow rate
Q'=Flow rate with safety coefficient
Discharges in…=Basin into which water is poured
Qtotal=Total flow rate

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS
BASIC DOCUMENT

Plan identification code: CRD_MF_LAK_7.1

Review: A

Project promoter: Gobierno de Navarra

Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)

Project maker: Asier Gamallo Valls

Plan title: Hydrology. Master Plan

Technical reference: Asier Gamallo Valls

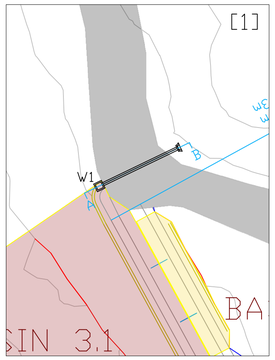
Approved by: Asier Gamallo Valls

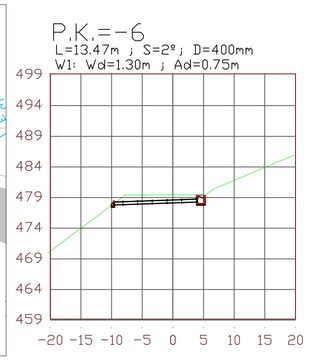
Edited (1st time): 20/04/2020

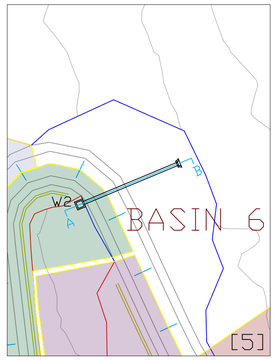
Edited (present): 28/04/2020

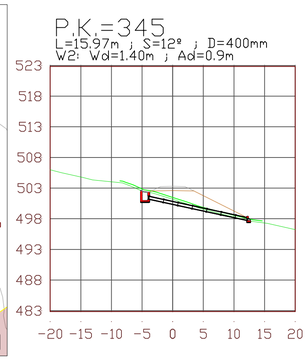
SCALE: 1/1500

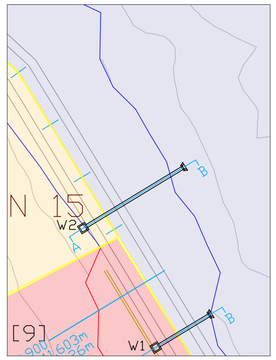
Plan number: 7.1

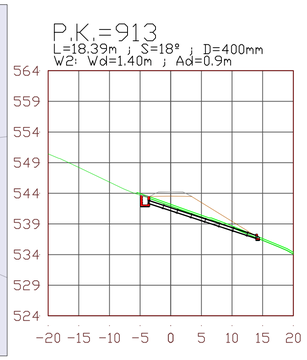


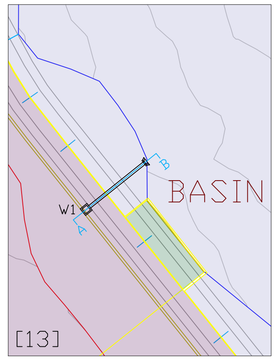


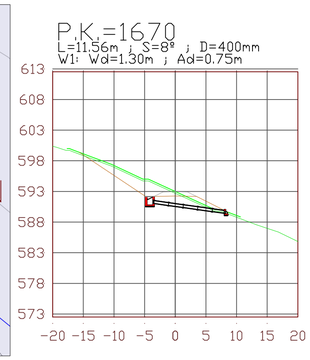


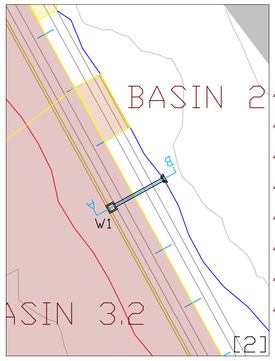


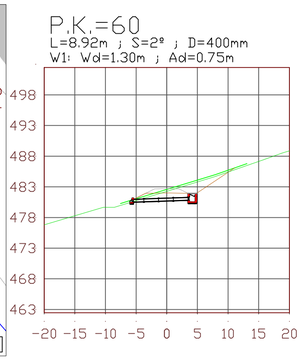


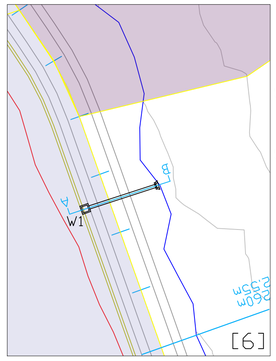


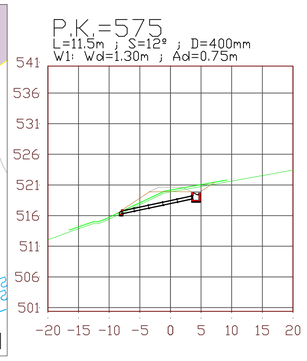


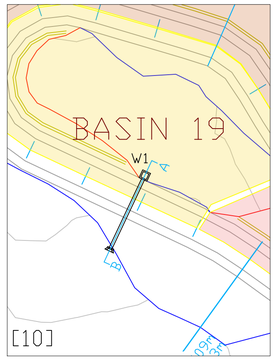


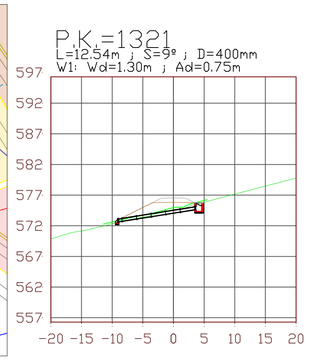


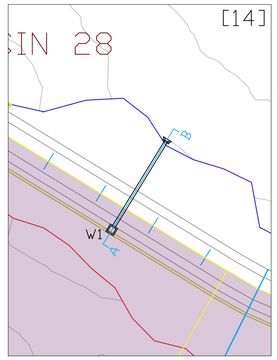


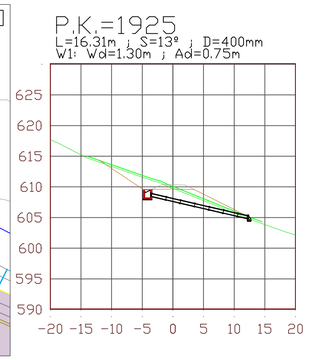


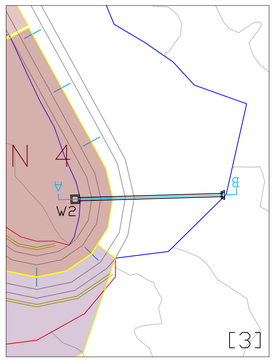


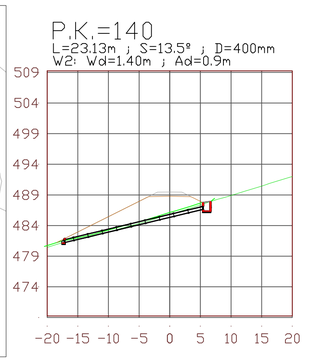


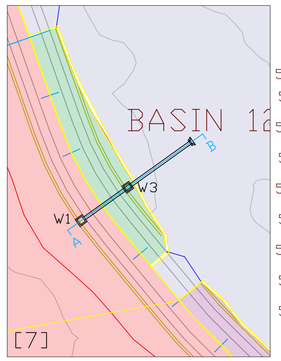


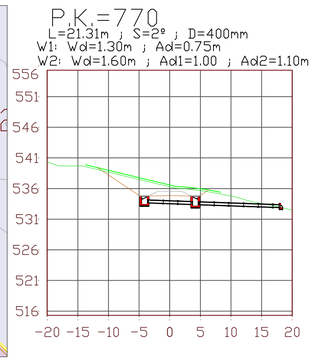


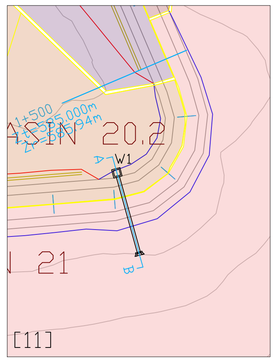


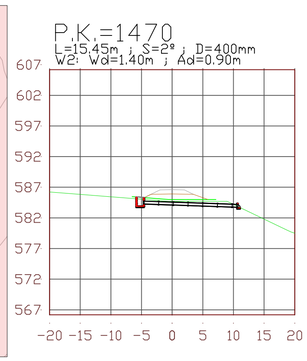


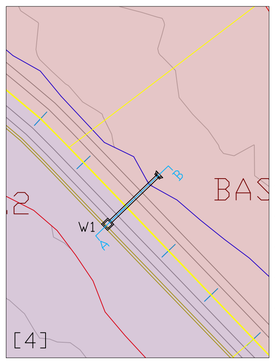


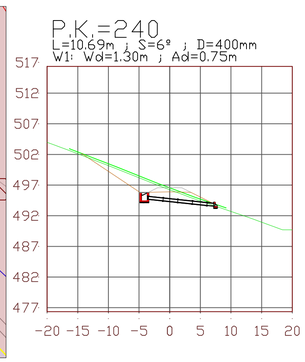


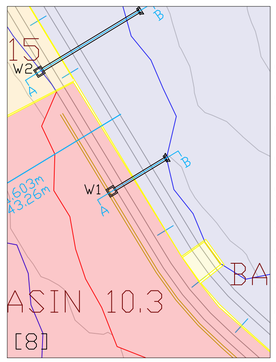


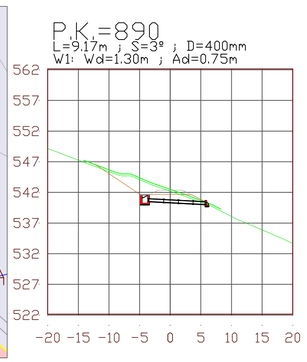


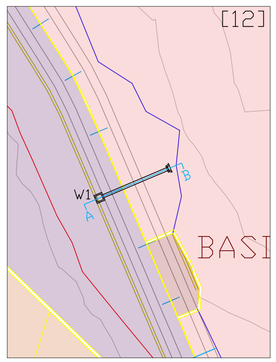


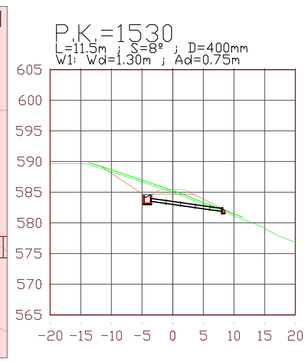












LEGEND

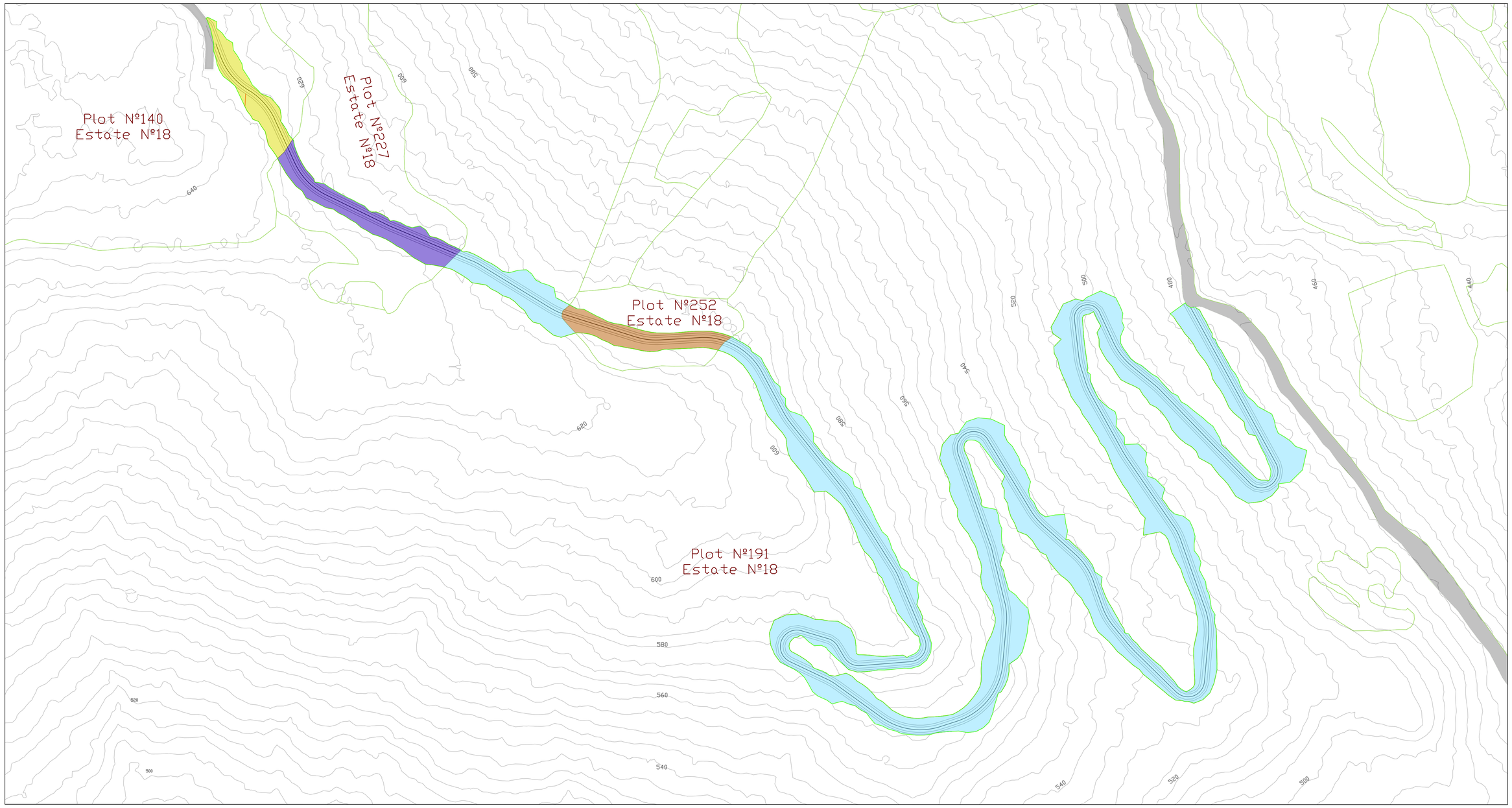
- Terrain
- Topsoil
- Base
- Subgrade and earth-works
- Drainage works

L=Length of the drainage pipe
S=Slope of the drainage pipe
D=Diameter of the drainage pipe
Wd=Well's depth
Ad=Axis' depth

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_7.2	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Hydrology. Drainage elements.	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 20/04/2020 Edited (present): 28/04/2020
SCALE: 1/500	Plan number: 7.2	



LEGEND

- Axis
- Base
- Final occupancy area
- Expropriation 1
- Expropriation 2
- Expropriation 3
- Expropriation 4
- Pre-existing country roads
- Contour lines
- Land registry

	Agricultural plot	Agricultural estate	Affected surface (m2)	Use	Class	Assesment (€)
Expropriation 1	191	18	34040,9091	Forest rangeland	3	491.0060
Expropriation 2	252	18	1779,2486	Forest rangeland	3	25.6638
Expropriation 3	227	18	2478,0241	Forest rangeland	3	37.7430
Expropriation 4	140	18	1646,8150	Forest rangeland	3	25.0337

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS
BASIC DOCUMENT

Plan identification code: CRD_MF_LAK_8

Review: A

Project promoter: Gobierno de Navarra

Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)

Project maker: Asier Gamallo Valls

Plan title: Expropriations

Technical reference: Asier Gamallo Valls

Approved by: Asier Gamallo Valls

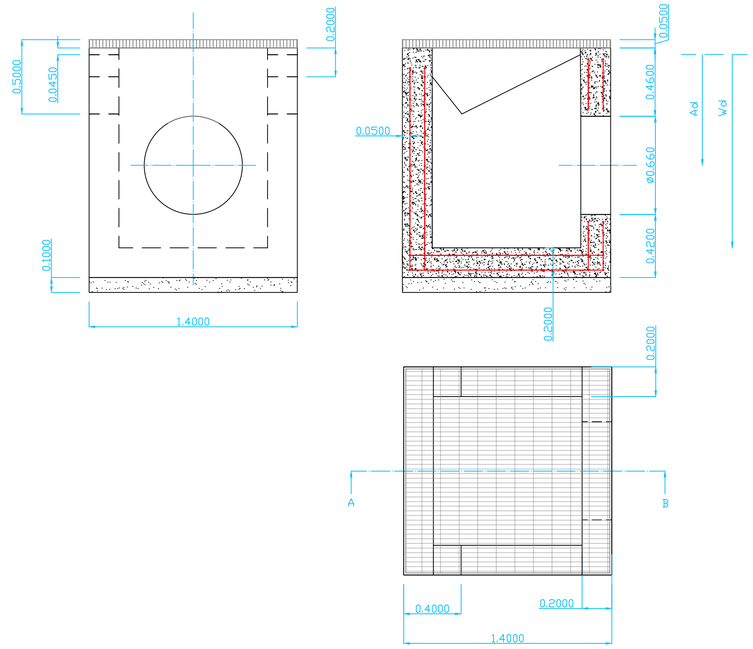
Edited (1st time): 13/03/2020

Edited (present): 28/04/2020

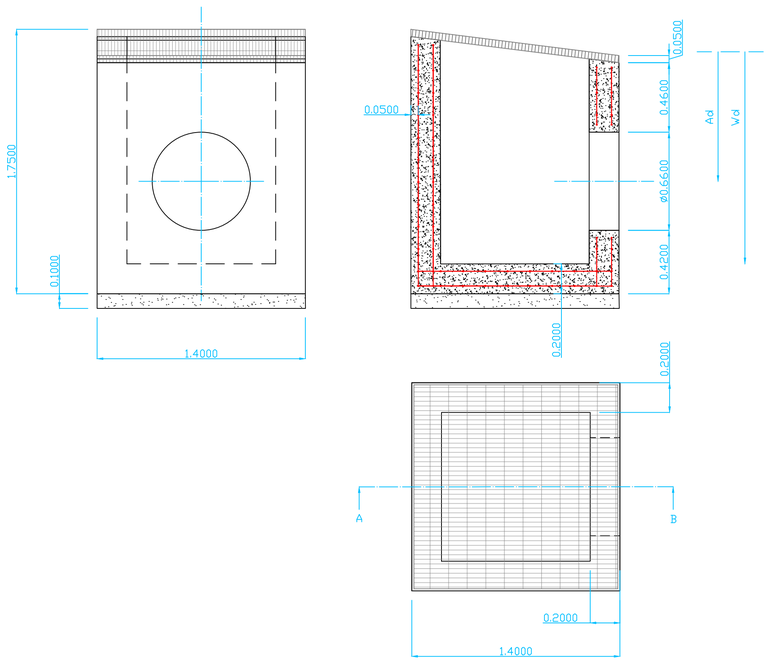
SCALE: 1/1500

Plan number: 8

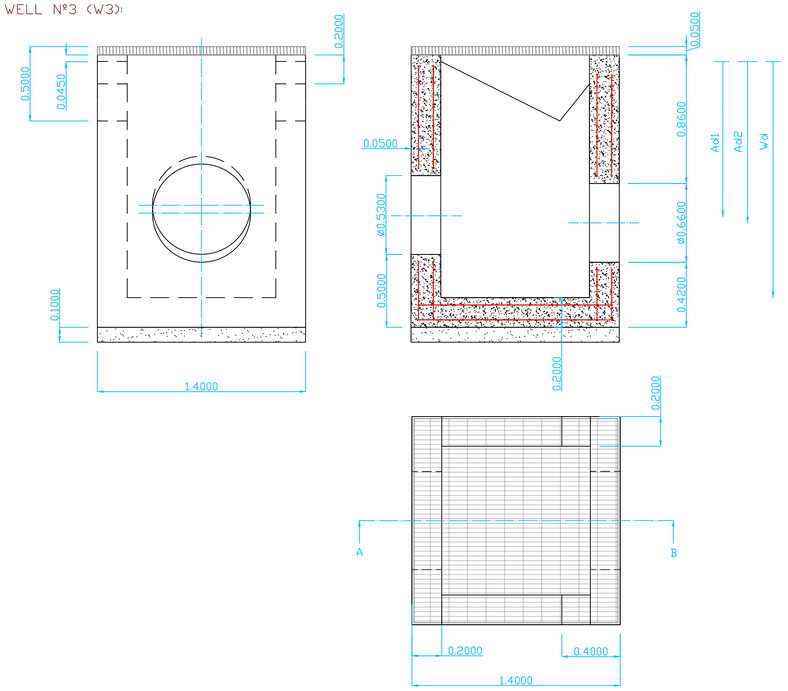
WELL Nº1 (W1):



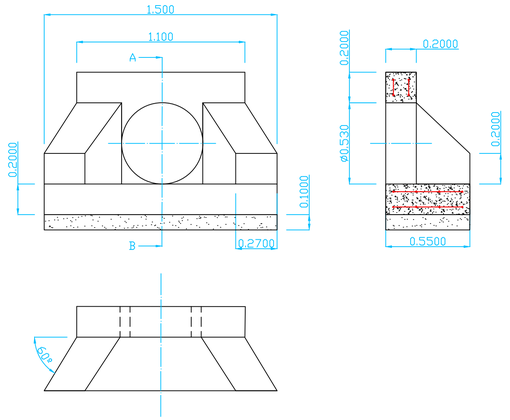
WELL Nº2 (W2):



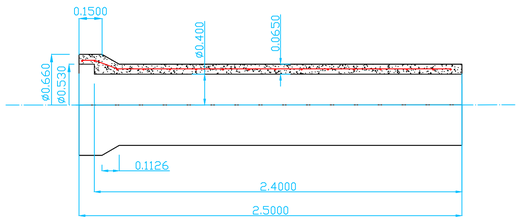
WELL Nº3 (W3):



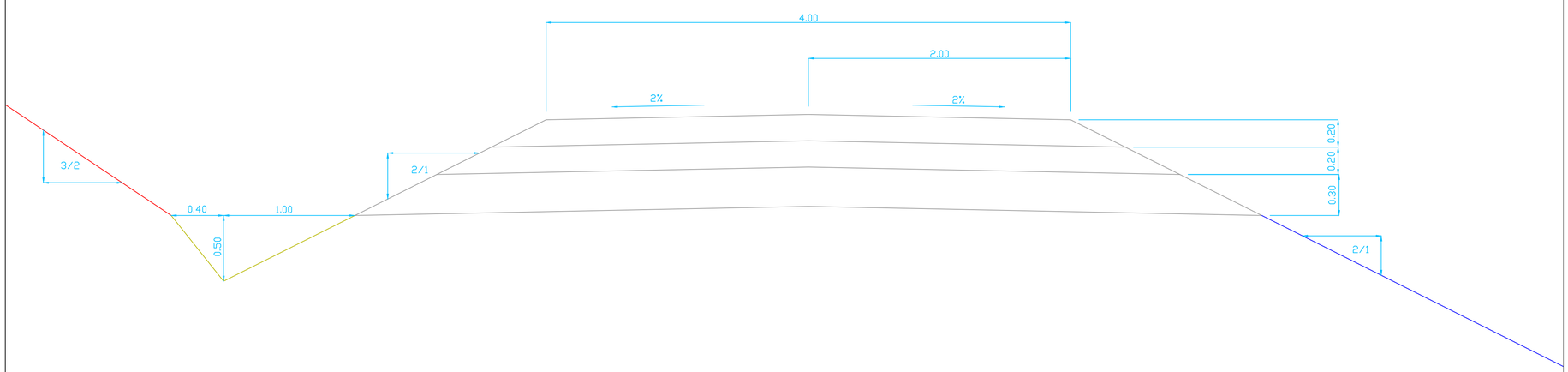
WINGWALLS:



PIPE (factory work):



COUNTRY ROAD CROSS-SECTION:



MATERIAL CHARACTERISTICS ACCORDING TO EHE-08					
CONCRETE					
STRUCTURE	TYPE	CONTROL	PARTIAL SAFETY COEFFICIENT (γ_c)	CALCULATION RESISTANCE (N/mm^2)	MINIMUM COVER (mm)
Wells	HA-25/S/20/IIb	Normal	1.5	25	50
Wingwalls	HA-25/S/20/IIb	Normal	1.5	25	50
Pipe	HA-35/S/20/IIb	Normal	1.5	35	50
Lean concrete	HL-150/B/20	Normal	1.5	35	
STEEL					
STRUCTURE	TYPE	CONTROL	PARTIAL SAFETY COEFFICIENT (γ_s)	CALCULATION RESISTANCE (N/mm^2)	MINIMUM COVER (mm)
Wells	15/15/8 B500T	Normal	1.15	434.78	-
Wingwalls	15/15/8 B500T	Normal	1.15	434.78	-
Pipe	B500S	Normal	1.15	434.78	-

LEGEND

- Concrete
- Concrete transversal cut
- Lean concrete
- Concrete reinforcements
- Tramex pad
- Pavement
- Cut
- Fill
- Gutter system
- Dimensioning

upna

College of Agricultural Engineering and Biosciences
Agricultural and Rural Environment Engineering Degree
FINAL PROJECT

PLANS BASIC DOCUMENT	Plan identification code: CRD_MF_LAK_9	Review: A
Project promoter: Gobierno de Navarra	Project: Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	
Project maker: Asier Gamallo Valls	Plan title: Items and pieces.	
Technical reference: Asier Gamallo Valls	Approved by: Asier Gamallo Valls	Edited (1st time): 23/04/2020 Edited (present): 30/04/2020
SCALE: 1/20	Plan number: 9	

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº4: Requirements Document

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

General Technical Requirements

-REQUIREMENTS DOCUMENT -

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. REGULATORY FRAMEWORK

The following Rules, Instructions, Requirements and Laws must be applied in all that is not established in the Special Technical Requirements.

- Law 9/2017 of November 8th on Public Sector Contracts transposing into Spanish law the Directives of the European Parliament and of the Council 2014/23/EU and 2014/24/EU of 26 February 2014.

- Decree 3854/1970, of December 31st, approving the General Administrative Clauses for the Procurement of State Works.

- Royal Decree 105/2008, of February 1st, regulating the production and management of construction and demolition waste.

- Law 21/2013, of December 9th, on environmental assessment.

- Law 32/2006, of October 18th, regulating subcontracting in the Construction Sector and Royal Decree 1109/2007, of August 24th, which develops Law 32/2006, of October 18th, governing the subcontracting in the Construction Sector.

- Law 31/1995, of November 8th, on the Prevention of Occupational Risks and Royal Decree 1627/1997 of October 24th laying down minimum Safety and Health Provisions on construction works.

- General Technical Requirements for Road and Bridge Works, M.O.P. of February 6th, 1976 and subsequent amendments.

- Ordinance FOM/2523/2014, of December 12th, updating certain PG-3 articles relating to basic materials, firm and pavement and signaling, beaconing and vehicle containment systems. (BOE January 3rd, 2015)

- Ordinance FOM/273/2016, of February 19th, which approves The Standard 3.1-IC Layout, of the Road Instruction.

- Ordinance FOM/298/2016, of February 15th, which approves the Rule 5.2-IC Surface Drainage of the Road Instruction
- Ordinance FOM/3460/203, of November 28th, approving the Rule 6.1 -IC Firm sections, of the Road Instruction.

- Ordinance FOM/3459/203, of November 28th, which approves the Rule 6.3 -IC Rehabilitation of firms, of the Road Instruction.

- Royal Decree 1247/2008, of July 18th. Structural Concrete Instruction (EHE-08).

- Laws concerning working conditions and current provisions governing the relations between Companies and Workers.

And other complementary regulations and other specific legislative rules and technical instructions that are currently in force.

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Special Technical Requirements

-REQUIREMENTS DOCUMENT -

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. DESCRIPTION OF THE WORKS

1.1. OBJECT AND CONTENT OF THE REQUIREMENT DOCUMENT

This specification lays down the special technical requirements which, in addition, of the administrative, economic and technical clauses governing the corresponding contract, will have to govern for the execution of the works described in this project and that are located within the scope of Gobierno de Navarra.

1.2. MAIN GEOMETRIC CHARACTERISTICS OF THE WORK

The axis of the country road will follow the paths defined by the alignments and curves in the Plans. The grade line will conform to the provisions of the setting-out of the works.

The total width of the country road, the dimensions of the firm and the gutters, as well as the subgrade, etc., will be those listed in budgets and Plans.

The cuts and fills slopes must have the inclination indicated in the cross-sections and in the rest of the Plans and dependent on the grade line.

The items and pieces made on-site and the factory works shall conform to the characteristics contained in the Plans. Omissions in the Plans, Requirements Document or incorrect descriptions, if any, of the details of the works that are indispensable to carry out the aim exposed in the Plans and Requirement Document that by their use and custom must be executed, not only do not exempt the Contractor from the obligation to execute them, but on the contrary, they must be carried out as if they had been completed and correctly specified in the Plans and Requirements Document.

1.3. WORK UNITS TO BE PERFORMED

The work units to be carried out are indicated in the Budget, and a non-exhaustive description is as follows:

The construction phase is planned by clearing and profiling the country road, profiling the gutters, scarified when necessary, regularization of the firm with the addition of aggregates and contribution of granular material.

2. GENERAL PROVISIONS RELATING TO MATERIALS AND WORK

2.1. MATERIALS IN GENERAL

All materials to be used in the execution of the works must meet the characteristics indicated in this Requirement Document and in the price charts, and deserve the conformity of the Work Director, even if their origin is fixed in the project.

The Work Director has the power to reject at any time, materials that he considers not to meet the conditions of the Requirement Document, or that are unsuitable for the good result of the work.

Rejected materials shall be removed from the work within the time limit indicated by the Director.

The Contractor shall notify the Work Director well in advance of the origin of the materials, providing the samples and data necessary to determine the possibility of their acceptance.

The acceptance of a source or quarry does not nullify the right of the Work Director to reject those materials that, in his opinion, do not meet the conditions of the Requirement Document, even if such materials were already put into work.

2.2. ANALYSIS AND TESTING FOR THE ACCEPTANCE OF THE MATERIALS

In relation to what is prescribed in this Requirements Document regarding the characteristics of the materials, the Contractor is forced to attend or admit, at all times, those tests or analyses that the Work Director deems necessary to perform to test the quality, strength and remaining characteristics of the materials used or to be used.

The choice of laboratories and the prosecution and interpretation of such analyses must be the exclusive competence of the Work Director.

In view of the results obtained, it will reject materials that it considers do not respond to the conditions of this Requirement Document.

The costs arising from the taking and transport of samples and the tests and analysis thereof, which are ordered by the Work Director, must be paid in accordance with clause 38 of the Administrative Requirement Document general for the Procurement of Works of Public Administrations in the works for the Administration.

2.3. MATERIALS NOT SPECIFIED IN THS REQUIREMENT DOCUMENT

The materials to be used in the works and that are not specified in this Requirement Document can not be used without having been previously recognized by the Work Director, who may admit or reject them, regardless of whether they comply or not the conditions that are, in his opinion, enforceable and without the Contractor being entitled to any claim.

2.4. WORKS IN GENERAL

As a general rule, the Contractor must carry out all the work adopting the best constructive technique that is required for its execution and complying, for each of the different units, with the provisions prescribed in this Requirement Document. It must also take the necessary precautions during construction.

Rejected works must be demolished and rebuilt within the time limit fixed by the Work Director.

2.5. MECHANICAL EQUIPMENT

The construction company must have the necessary mechanical means, with suitable personnel for the execution of the works included in the project.

Machinery and other work items must be, at all times, in perfect operating condition, and will be attached to the site during the course of execution of the units in which they are to be used, not being able to withdraw them without the consent of the Work Director.

2.6. ANALYSIS AND TESTING FOR THE QUALITY CONTROL OF WORKS

The Contractor is forced, at any time, to submit the works executed or in execution, to the analyses and tests that in class and number the Work Director deems necessary for the control of the work or to check its quality, resistance and other characteristics.

The prosecution of the results of the analyses and tests will be the exclusive competence of the Work Director, who will reject those works that he considers do not respond in his execution to the rules of this Requirements Document.

The costs arising from the taking and transport of samples and the analyses and tests thereof, will be paid in accordance with Clause 38 of the General Administrative Clauses for the Procurement of Works of Public Administrations.

2.7. WORKS NOT INCLUDED OR WORKS NOT SPECIFIED IN THE REQUIREMENT DOCUMENT

Those units of construction that were not included or those works that were not specified in the Requirement Document, will be executed in accordance with the sanctioned by the experience as rules of good construction or execution, the Contractor must follow, scrupulously, the special rules that, in each case, indicated by the Work Director, according to his unappealable judgment.

2.8. STOCKPILING

The 75% of the material collected at the price charts of the Budget shall be evaluated and certified, provided that the Contractor has obtained prior written authorization from the Work Director for the acquisition of the materials concerned and there is bank guarantee.

2.9. TERMINATIONS

Where incomplete works need to be assessed for termination and other causes, the prices of the Budget will be applied, without being intended the valuation of each work unit, fractionated it in any way other than that set out in the used prices database.

In no case the Contractor will be entitled to any claim, based on the insufficiency, error and omission of the price charts, or omissions of any of the elements that constitute those prices.

2.10. WARRANTY

The warranty period will be 1 (ONE) YEAR, being in this period on behalf of the Contractor the conservation and repair operations in the works included in the contract.

The Contractor is responsible as a patron of compliance with all current labor laws and provisions, also complying with what the Work Direction dictates to him for the safety of the operators.

2.11. EXCESS WORK

As a general rule, in no case will be paid the excess work, in any unit of the project, which, for convenience or bad execution, performs the Contractor, without the proper authorization by the Work Director.

3. PROVISIONS RELATING TO WORK

Within this subtitle are grouped by chapters corresponding to the operations of the work that is projected and that are:

- 3.1. EARTHWORKS.

  Provisions relating to:

  - Clearing.
  - Subgrade formation
  - Cuts and excavations.
  - Trench and Well excavations.
  - Excavation in Lending areas
  - Fills.

- 3.2. DRAINS.

  Provisions relating to:

  - Drains systems

- 3.3. PAVEMENT.

  Provisions relating to:

  - Granular bases.

- 3.4. SIGNALLING, BEACONING AND DEFENSES

  Provisions relating to:

  - Signs and retroreflective circulation vertical signs.

3.1. EARTHWORKS

3.1.1. CLEARING

a) Definition

Work to take down, extract and remove from the country road occupation area any obstacle to the work, such as trees, stumps, scrub or any other material affecting the trace of the country road to be built.

b) Execution of the works

Topsoil must be removed from the land surfaces affected by excavations or embankments, according to the depth of 30 cm defined in the project, which be verified or redefined by the Work Director. Roots with diameters greater than 10 cm must be removed below the surface of the natural ground up to at least 50 cm deep from the grade line.

The topsoil from the clearing must be disposed of in its final location in the shortest possible time interval. In case it is not possible to use it directly, it must be stored in piles not higher than 2 m. It should not be subjected to the passage of vehicles or to overloads, neither before removal nor during storage, and transfers between points should be kept to the minimum.

Once the stumps, roots or any other material that needs to be removed have been detached, the resulting holes will be covered with soil that will be compacted until the surface conforms to that of the rest of the terrain.

Any other operation not contemplated in this Requirement Document will be done based on Article 300.2.2 of the PG-3 or at the discretion of the Work Director

c) Measurement and payment

The work executed in accordance with the rules described above and those in the price chart and other project documents will be measured in hectares (ha) and paid.

3.1.2. SUBGRADE FORMATION

a) Definition

Works to obtain the conditions desired for the native material on which the country road will be settled.

b) Execution of the works

On newly constructed country roads, the land must be dismantled to a depth that ensures not only the removal of the plant soil layer, but also those that do not support the unit loads to be transferred by the country road. In the same way, all loose or removed materials, decomposed or altered by the action of atmospheric agents and, in general, all those capable of hindering a good union between the body of the country road and the natural terrain will be removed.

All these materials must be removed from the area of occupation at the distance determined by the Work Director.

The foundation surface will be compacted, and if necessary, will be scarified and humidified in advance.

During the various construction stages of the subgrade, the works will be kept in perfect drainage conditions and the gutters, curbs, and other drainage elements will be arranged so that erosion does not occur on the slopes.

Any other operation not contemplated in this Requirement Document will be done based on Article 302 of the PG-3 or at the discretion of the Work Director

c) Quality control

The degree of compaction in the subgrade will be 100% of the Modified Proctor.

The execution of the work shall be monitored by carrying out tests, the frequency and type of which are indicated below, being understood that, at least, those figures will be fulfilled.

For every 3,000 to 5,000 m^2:

- A moisture test.
- A granulometric test.
- A determination of Atterberg Limits or two sand equivalents.

- An "in situ" density test.

For every 10,000 m^2:

- A compaction test.

3.1.3. CUTS AND EXCAVATIONS

a) Definition

Set of operations to excavate and level the areas where the country road is going to be settled, including the platform, slopes and gutters, as well as the loan areas, planned or authorized, and the consequent transportation of the removed products to the warehouse or place. of employment.

b) Cuts classification

The cuts or excavations shall be classified according to the PG-3 Article 320.2 considering the nature of the land, within one of the following three classes:

- Excavation in rock: It is the one made in those materials so cemented that they need to be excavated by use of explosives.

- Excavation in transit lands: It is the one made in very compact rocks or lands and, in general, in all those materials that need the use of powerful machinery for previous scarification work.

- Excavation in normal consistency lands: Understands the excavation of those materials whose consistency allows the direct action of normal excavation machines: Bulldozers, trails, excavators, etc.

c) Execution of the works

Once the previous work has been completed and inspected and admitted by the Work Director, the excavation work will be carried out according to the alignments, slopes, dimensions and other data determined and contained in the project. The Contractor must notify the Work Director sufficiently in advance of the beginning of any excavation, and the planned execution system, to obtain its approval.

For this purpose, it should not resort to the use of excavation systems that do not correspond to those included in the Specific Technical Requirement Document or in the Plans, especially if the intended variation could excessively damage the terrain.

During the execution of the works, in any case, adequate precautions will be taken in order to not decrease the resistance or stability of the unexcavated terrain. It will be essential to pay attention to the tectonic-structural characteristics of the environment and to its drainage alterations, and the necessary measures will be adopted to avoid the following phenomena:

- Instability of rock slopes or rock blocks.
- Inadequate blasting.
- Landslides caused by the unevenness of the foot of the excavation.
- Waterlogging due to drainage problems in the works.
- Excessive provisional slopes.
- etc.

In all cases, the provisions of current legislation on environmental, Safety and Health, and storage and transportation of construction products will be followed.

On the one hand, whenever possible, the materials obtained from the excavation will be used in the fill formation and other uses established in the project, and will be transported directly to the areas provided for in it, failing that, will be applied to what In this regard, the Director of the Works may order. On the other hand, excavated non-usable materials will be transported to an authorized landfill, without giving the right to an extra payment. The landfill areas for these materials will be those defined in the project or, failing that, those authorized by the Work Director at the proposal of the Contractor, who must obtain the appropriate permits at his own expense and provide a copy of them to the Work Director.

The excavation of the cuts will be carried out properly in order to avoid the damage of its final surface, avoid premature or excessive decompression of at its base and prevent any other cause that may compromise the stability of the final excavation. If the excavation of the cut is definitive and is carried out by drilling and blasting the rock, the provisions of PG-3 Article 322, "Special excavation of rock slopes" will be complied with.

The trenches that, according to the project, must be built at the base of the cut, will be excavated so that the affected terrain does not lose resistance due to deformation of the walls of the trench or due to faulty drainage. The trench will be kept open for the minimum necessary time, and the filling material will be carefully compacted. In this way, special care will be taken to limit the length of the open trench at the same time, in order to reduce the effects.

When special measures are necessary to protect the surface of the slope, such as riprap walls, surface plantations, coating, etc., the works must be carried out as soon as the excavation of the slope allows it.

Efforts will be made to give an aspect to the final surfaces of the slopes, whether or not they are covered with topsoil, that harmonizes as much as possible with the existing natural landscape.

The transition from cut to fill will be carried out gradually, adjusting and smoothing the slopes, and taking the necessary drainage measures to prevent water from entering the base of the fill.

Particular care will be taken in the fill-cut contact areas in which the excavation will expand until the crown of the fill penetrates it throughout its section, not accepting sections in which the support of the crowning of the fill and the excavation bottom are in different planes. In these contacts, the drainage of these areas will be studied especially in the project and the necessary measures will be considered to avoid their flooding.

In the event in which the slopes were damaged before the reception of the works, the Contractor will eliminate the detached or moved materials and urgently carry out the additional repairs ordered by the Work Director. If the aforementioned damages were attributable to improper execution or non-compliance with the instructions of the Work Director, the Contractor will be responsible for the damages and additional costs caused. The Special Technical Requirement Document will define the finishing tolerances or, failing that, they will be defined by the Work Director. All types of rectification operations for breach of tolerances will not be credited to the Contractor running all these operations from his account

During the various stages of the construction of the subgrade, the works will be kept in perfect drainage conditions and the gutters, curbs, and other drainage elements will be arranged so that erosion does not occur on the slopes.

Any other operation not contemplated in this Requirement Document will be done based on Article 320 of the PG-3 or at the discretion of the Work Director

d) Measurement and payment

The work executed in accordance with the rules described above and those in the price chart and other project documents will be measured in cubic meters (m^3) and paid.

3.1.4. TRENCH AND WELL EXCAVATIONS

a) Definition

Set of operations necessary to open trenches and wells. Its execution includes the operations of excavation, shoring, possible depletions, leveling and evacuation of the land, and the consequent transportation of the removed products to the landfill or place of employment.

b) Trench and Well excavation classification

The prescriptions shown in the previous section will be applied.

c) Execution of the works

The Contractor will notify the Director of Works, in advance, of the beginning of any excavation, so that he can carry out the necessary measurements on the unaltered terrain. The natural terrain adjacent to that of the excavation shall not be modified or removed without authorization from the Work Director.

Once the setting out of the trenches or wells has been carried out, the Work Director will authorize the initiation of the excavation works. Excavation will continue until reaching the depth indicated in the project and a firm and clean level or staggered surface is obtained, as ordered. However, the Work Director may modify such depth if, in view of the conditions of the terrain, he deems it necessary in order to ensure a satisfactory foundation.

The fringes that border the excavation will be closely watched, especially if work is carried out inside them with the presence of people.

The Contractor shall also be obliged to carry out the excavation of inappropriate material for the foundation, and to replace it by appropriate material, provided that the Work Director orders it.

For the excavation of topsoil, the provisions of section explained above will be followed.

The necessary precautions shall be taken to prevent the degradation of the excavation bottom in the time interval between the excavation and the execution of the foundation or work in question.

In all cases, the provisions of current legislation on environmental, Safety and Health, and storage and transportation of construction products will be followed.

In those cases where shoring excavations are planned, the Contractor may propose to the Work Director to carry them out without it, explaining and fully justifying the reasons that support his proposal. The Work Director may authorize such modification, without implying any subsidiary responsibility. If the contract does not include shoring excavations and the Work Director, for safety reasons, deems it advisable that the excavations be carried out with it, he may order the Contractor to use shoring, without considering this independent payment operation.

When water appears in the trenches or wells during digging operations, the necessary means and auxiliary facilities will be used to exhaust it. The exhaustion from the inside of a foundation must be done in a way that does not cause the segregation of the materials that make up the foundation concrete, and in no case will it be carried out from inside the formwork before twenty-

four hours have elapsed since the concreting. The Contractor shall submit the detail Plans and other documents that explain and justify the proposed construction methods to the approval of the Work Director.

In the event that the slopes of the trenches or wells, executed in accordance with the Plans and orders of the Work Director, are unstable and, therefore, give rise to landslides before the reception of the works, the Contractor will eliminate the detached materials.

For the use of the excavation materials, the guidelines indicated above will be followed.

The bottom and side walls of the finished trenches and wells will have the shape and dimensions required in the Plans, with modifications due to unavoidable authorized excesses, and shall be refined to achieve a difference of less than 5 cm with respect to the theoretical surfaces. Unauthorized over-excavations must be completed in accordance with the specifications defined by the Work Director. This operation will not be corresponded with an independent payment. The filling necessary to reconstruct the theoretical type section will not be extra paid either.

However, authorized and unavoidable excesses will be paid.

Any other operation not contemplated in this Requirement Document will be done based on Article 321 of the PG-3 or at the discretion of the Work Director

d) Measurement and payment

The work executed in accordance with the rules described above and those in the price chart and other project documents will be in units (ud) and cubic meters (m^3) and paid.

3.1.5. EXCAVATIONS IN LENDING AREAS

Although in this project the use of Lending Areas is not going to be used, if yes, the Contractor shall inform the Work Director, with enough time and the prescriptions indicated in PG-3 Article 320.3.6 will be followed

3.1.6. FILLS

a) Definition

Set of operations that consists of the extension and compaction, by layers, of the materials in areas to create a platform on which the pavement of the country road will be settled.

b) Material characteristics, classification and use

The provisions related to the material characteristics and classification and its use established in PG-3 Sections 330.3.2, 330.3.3 and 330.4.1 will be followed.

c) Execution of the works

If the fill is built on natural land, the clearing and excavation work will be carried out first.

In fills on compressible and low-resistance soils, especially in organic soils or in swampy areas, the vegetation will be able to improve the support of the earthmoving machinery and facilitate the compaction operations of the first dumps. In these cases, the Work Director, may indicate its possible conservation.

After clearing, the natural terrain will be excavated and extracted to the extent and depth specified in the project.

When indicated by the project, or if the Work Director considers it necessary, layers of thick granular materials or geotextile sheets will be extended to allow or facilitate the implementation of the first layers of the fill.

The operations aimed at the construction of the fills will be those indicated in the project or, failing that, by the Work Director. When the embankment-type landfill has to settle on a land where there is surface water, the water will be conducted outside the area where it is going to be built, before starting its execution, through works that may have the character of accessory, and that will be carried out in accordance with the provisions for such works in the project or, failing that, following the instructions of the Work Director

The layers capable of being saturated during the life of the fill will be built, according to the project, with a material in which the particle size prevents the entrainment of particles and in which the deformations that may occur when saturating are acceptable for the conditions of service defined in the project.

Transitions from cut to fill will be carried out, both transversely and longitudinally, in the smoothest possible way as indicated in the project or, failing that, excavating the support terrain until achieving a slope of no more than 2/1. This slope will be maintained until reaching a depth below the subgrade of at least 1 m.

In fills located halfway up the slope, the natural slope of the land will be staggered according to what is indicated in the project. The sidewalks thus created must be supported on sufficiently firm ground. Their width and slope should be such that the machinery can easily work on them.

In general, and especially in the middle slopes where, in the short and long term, the presence of water is foreseen in the area of contact of the land with the fill, the necessary works, collected or not in the project, must be carried out to maintain such contact drained .

Since the clearing, scarifying and staggering operations of the slopes leave the ground surface easily eroded by atmospheric agents, these works should not be carried out until the planned time and under the appropriate conditions to minimize the exposure time, unless surface protections are used. The possibility of land terraces in the environment and other indirect conditions must be considered in the adoption of these protection measures.

Once the support for the fill has been prepared, its construction will be carried out, using the corresponding materials, which will be spread in successive layers, of uniform thickness and substantially parallel to the final esplanade.

The thickness of these layers will be adequate so that, with the available means, the required degree of compaction is obtained in all its thickness. The aforementioned thickness, in general and unless specified against the project or the Work Director, will be 30 cm. In any case, the thickness of the layer must be greater than 3/2 of the maximum size of the material to be used.

The paving or extension will be programmed and carried out in such a way that the materials of each layer are of uniform characteristics and, if they were not, this uniformity will be achieved by mixing them properly with adequate machinery for it. No layer will be extended until it has been verified that the underlying surface meets the required conditions and its extension is authorized by the Work Director.

Fills over areas with low bearing capacity will begin by pouring the first layers with the minimum thickness necessary to support the loads produced by the earth moving and compaction equipment.

During the execution of the works, the surface of the layers shall have the necessary transversal slope, generally around 4%, to ensure the evacuation of the waters without danger of erosion and to avoid the concentration of discharges. In fills of more than 5 m in height, and in all those cases in which a strong erosion of the exterior surface of the landfill is foreseeable, construction of earth ridges will be carried out on the edges of the slopes that, aided by the corresponding longitudinal slope, will carry the water to downspouts arranged to control runoff waters. It will also proceed to adopt the protective measures for the environment, provided for or not in the project or indicated by the Work Director, against the action, erosive or sedimentary, of runoff water.

Unless there is a prescription against the project or the Work Director, the land transport equipment and its extension will operate over the entire width of each layer and, in general, in the longitudinal direction of the country road.

It must be ensured that the entire profile of the fill is properly compacted, for which purpose, a width of one layer of the order of 1 m can be given that allows the compactor to approach the edge, and then cut the slope. In any case, these widths will not be paid.

In the event in which it were necessary to add water to achieve the expected degree of compaction, this operation will be carried out by uniformly humidifying the materials, either in the areas of origin (quarries, loans), either in intermediate storage or in the layer, arranging the adequate systems to ensure the aforementioned uniformity (prior crumbling, use of sheepsfoot rollers, etc.).

The work humidity will be established taking into account what it is established in PG-3 Article 330.4.3.

In special cases where the natural humidity of the material is excessive, appropriate measures will be taken to achieve the expected compaction, being able to proceed with drying by air, or the addition and mixing of dry materials or appropriate substances.

Once the most convenient humidification has been achieved, the layer will be compacted mechanically.

The project, or in its absence the Work Director, will indicate the Modified Proctor according to UNE 103501, the test to consider as the Reference Proctor test. The different fill layers will be compacted until reaching 100% of the Modified Proctor in the crown and 95% in the foundation areas. kernel and shoulders of the fill.

The fills will be executed when the ambient temperature, in the shade, is higher than 2ºC, and work should be suspended when the temperature falls below this limit, unless the viability of commissioning is adequately justified. work and the achievement of the required characteristics and this justification was accepted by the Work Director.

The Work Director will take into account the influence of the rains before approving the spread and compaction of the fill.

On the running layers, the action of all types of traffic should be prohibited until their compaction has been completed. If this is not feasible, the thickness of the tons affected by the passage of traffic will be eliminated.

In the event in which the slopes were damaged before the reception of the works, the Contractor will eliminate the detached or moved materials and urgently carry out the additional repairs ordered by the Work Director. If the aforementioned damages were attributable to improper execution or non-compliance with the instructions of the Work Director, the Contractor will be responsible for the damages and additional costs caused. The Special Technical Requirement Document will define the finishing tolerances or, failing that, they will be defined by the Work

Director. All types of rectification operations for breach of tolerances will not be credited to the Contractor running all these operations from his account

Any other operation not contemplated in this Requirement Document will be done based on Article 330 of the PG-3 or at the discretion of the Work Director. The fills will be compacted with suitable equipment (smooth rollers, pneumatic wheel compactors, vibrating compactors, etc.), regulating the number of passes until the required density is reached.

d) Quality control

The execution of the work shall be monitored by carrying out tests, the frequency and type of which are indicated below, being understood that, at least, those figures will be fulfilled.

For every 1000 m^3:

- A moisture test.
- A granulometric test.
- A determination of Atterberg Limits

For every 2000 m^3:

- A compaction test.

For every 2000 m^3 or fraction of each compacted stratum:

- An in-situ density test

e) Measurement and payment

The work executed in accordance with the rules described above and those in the price chart and other project documents will be measured in cubic meters (m^3) and paid.

3.2. DRAINS

3.2.1. DRAINS SYSTEMS

a) Definition

Construction made on-site or in the factory with stone, brick, steel, concrete and / or, in general, with stone materials, which is part of a country road.

b) Materials

In general, all the materials used in the drainage system construction will comply with what is specified in the instructions and regulations in force that affect them, as well as in the corresponding articles in this Requirement Document. In any case, the provisions of the legislation in force regarding the environment, Safety and Health, and the storage and transportation of construction products will be followed.

The provisions of this chapter shall be understood without prejudice to the provisions of Royal Decree 1630/92 (modified by RD 1328/95), which establishes the provisions for the free movement of construction products, in application of Directive 89/106 EEC. In particular, regarding special recognition procedures, the provisions of Article 9 of the aforementioned Royal Decree will be followed.

The following specific requirements must also be fulfilled:

Concrete:

- Structural Concrete Instruction (EHE).
- Cement Reception Instruction.
- PG-3 Articles 610 "Concrete" and 630: "Works of concrete in mass or reinforced".
- The leaning and filling concretes must have a minimum characteristic compressive strength of 12,5 MPa at 28 d.
- UNE – 12390

Brick factory:

- PG-3 Article 657, "Brick factories".
- General Requirement Document for the Reception of ceramic bricks at construction sites.
- The bricks to be used will be solid.

Concrete blocks:

- General Technical Requirements for the Reception of concrete blocks in construction works.

Concrete prefabricated parts:

- Structural Concrete Instruction (EHE).
- Minimum characteristic compressive strength 25 MPa, at 28 d.
- The transport, unloading and storage will be carried out carefully, being rejected those parts that present defects.

Melting iron for lids and fences:

- UNE EN 1561 and UNE EN 1563.

Cement:

- Structural Concrete Instruction (EHE).
- It will be received on site in the same closed packaging in which it was shipped from the factory and will be stored in ventilated and defended place, both from the weather and from the moisture of the floor and walls. If it is bulk it will be subject to the conditions established for this type of storage.

Water and aggregates for mortars and concretes:

- Structural Concrete Instruction (EHE).

Wood:

- It can be of any kind provided as long as it has been cut in an appropriate time, is well dry, without smell of moisture, does not present knots and gives a clear noise to the mace blow, offering for its squadron the necessary resistance for formwork, scaffoldings and other auxiliary means.

Concrete reinforcement:

- Structural Concrete Instruction (EHE).
- Minimum elastic limit of 400 N/mm^2.

Other materials not specified:

- Other materials for which no conditions are detailed, will be of first quality, will meet the conditions required for such materials in PG-3.

c) Execution of the works

The tolerances in the dimensions of the body of the manholes shall not exceed ten millimeters (10 mm) with respect to that specified in the project Plans.

Pipe and gutter connections will be made at the levels indicated in the project Plans, so that the ends of the ducts are flush with the interior faces of the walls.

The upper part of the work will be arranged in such a way that spillage of the surrounding land on or into it is avoided.

The covers or grids will fit the body of the work and will be placed so that its outer face is at the same level as the adjacent surfaces. They will be designed to withstand the passage of traffic and precautions will be taken to prevent theft or displacement.

In the event that the project considers it necessary, a leak test will be carried out.

The backfill of the factory will be filled, in general, with material from the excavation, in accordance with PG-3 Article 332, "Localized landfills", or with concrete, as indicated in the project.

In all cases, the provisions of current legislation on environmental, Safety and Health, and storage and transportation of construction products will be followed.

The pipe that will connect the well (upstream of the cross-drainage work (ODT)) with the wingwall (downstream of the cross-drainage work (ODT)), which will be reinforced concrete pieces made on-work, will be disposed just below the base of the country road with a 2% minimum slope (as indicated in the Plan Nº 7.2), always favoring the rapid evacuation of water from the mentioned area.

In the event that other parts made on-site were to be carried out in the work, the Structural Concrete Instruction (EHE) and the specific orders of the Work Direction will be followed at all times. The concreting of any element shall be brought to the attention of the Management Direction in advance. The express authorization of that person will be necessary to initiate the dumping of the concrete. In control tests, in those cases in which the characteristic resistance is less than that required, the Contractor will be forced to accept the corrective measures adopted by the Work Director, reserving at all times the right to reject the work element concerned, or to accept it at a lower price than that established for that unit. The quality control of the concrete and its different components shall comply with the provisions of Article (82) of the EHE.

If formworks and stripping were needed, they will be carried out in accordance with what is required in the current Instruction. In any case, the formwork used in the concrete factories must be suitable for the proposed purpose. In particular, they will have the necessary rigidity to withstand without appreciable deformation the thrusts to which they are to be subjected.

In that case, the placement of the armor shall be in place in the provisions of the EHE, or as indicated by the technical Work Direction. It shall be made of clean armor, free of grease, oxide or other dirt and must be arranged in accordance with the indications of the Plans. They shall be fixed

to each other by the appropriate bindings and at the specified distance of the formwork, so that its position does not vary during the pouring and vibrating of the concrete.

Defects, deformations, cracks, breaks, etc., inadmissible in the opinion of the Work Director, which present the factory works, will be sufficient reason to order its demolition, with the consequent reconstruction, by the Contractor, all according to the unappealable judgment of the Work Director.

Any other operation not contemplated in this Requirement Document will be done based on Article 410 of the PG-3 and on the Rule 5.2-IC Surface Drainage of the Road Instruction (Orden FOM/298/2016) or at the discretion of the Work Director.

d) Measurements and payment

The work executed in accordance with the rules described above and those in the price chart and other project documents will be measured in units (ud), meters (m) and cubic meters (m^3) and paid.

3.3.PAVEMENT

3.3.1. GRANULAR BASES

a) Definition

Given the characteristics and requirements of this project, the granular bases are the mixture of arid gravel from construction or demolition wastes (RCD), consisting of fragments or remains of bricks, concrete, mortar, steel, iron, among others, with a continuous granulometry within a given class.

b) Materials

As far as the pavement dimensioning method is concerned, the following types of aggregates have been determined to be used:

- SR-SEL: Recycled RCD selected soil.
- ZARM I: Mixed recycled artificial ballast type I.

- ZARHor: Concrete recycled artificial ballast.

c) Conditions of the materials

For the present country road and as it is stated in the Article 510 of the Ordinance FOM/2523/2014, of December 12th, being in a heavy traffic category between T2 and T4, recycled granular materials, recycled aggregates from construction and demolition waste (RCD) may be used provided that they comply with the technical prescriptions required in the aforementioned Article, and the origin of the materials is declared, as established in the community legislation on these matters.

The recycled aggregates from construction and demolition waste will undergo, in fixed or mobile plants, a process of separation of unwanted components, screening and final removal of contaminants.

The Specific Technical Requirements Document, or failing that, the Work Director, may set additional specifications when materials whose nature or origin so require are to be used.

The materials for the ballast layers will not be susceptible to any appreciable weathering or physical-chemical alteration under the most unfavorable conditions that, presumably, may occur in the area of use. Long-term durability must be guaranteed, as well as that they cannot give rise, with water, to solutions that may cause damage to structures or other pavement layers or contaminate the ground or water currents. For this reason, in materials in which, by their nature, there is not enough experience on their behavior, a special study must be made of their aptitude to be employed, which must be approved by the Work Director.

All the properties of the recycled aggregates explained below must be included in:

- CE label.

- ANEFA or GERD sheet or similar.

In addition, the supplier must state in a responsible declaration that the material complies with current regulations, especially environmental regulations.

If there are aspects not defined in this chapter of the specifications, the provisions of PG-3/75 of the MOPU and the *Pavements and Construction units with Recycled Aggregates from Construction and Demolition Wastes (RCD) Catalogue* (Junta de Andalucía, 2016) will be complied with.

d) Composition of the materials

As indicated in the UNE-EN 933-11, the identification and estimation of the relative proportions of the components of the recycled coarse aggregates is carried out in accordance with the Standard (Table 18).

Table 18: Composition of the materials

Composition	ZARHor	ZARM I	SR-SEL
Rc+Ru+Ra	-	$\geq$ 70%	
Rc+Ru	$\geq$ 90%	$\geq$ 55%	
Rc	-	-	
Ra	-	-	
Rb	-	-	
X	< 1%	< 1%	< 3%
FL	< 1 cm^3/kg	< 1 cm^3/kg	< 2 cm^3/kg
Plaster			< 1%

Where:

- Rc: Concrete, concrete products, mortar. Parts for concrete masonry factory.
- Ru: Untreated aggregates, natural stone Aggregates treated with hydraulic binders
- Ra: Bituminous materials
- Rb: Pieces for clay masonry factory (bricks and tiles). Parts for calcium silicate masonry factory. Non-floating foam concrete
- X: Others: Cohesive materials (clay and soil), Various metals (ferrous and non-ferrous) Non-floating wood, plastic and rubber, Plaster
- FL: Floating material in volume

e) Granulometry

As indicated in the UNE-EN 933-1 the granulometric class of the material must be adjusted to one of the following limits (% passing in the mass basis) (Table 19) (Table 20):

Table 19: Granulometry of the ZARHor and ZARM I materials

	ZARHor and ZARM I		
SIEVES	0/32 (min. aggregate diameter/max. aggregate diameter)	0/20	0/20 ZAD
56	-	-	
45	-	-	
40	100	-	
32	88-100	100	100

	ZARHor and ZARM I		
SIEVES	**0/32** (min. aggregate diameter/max. aggregate diameter)	**0/20**	**0/20 ZAD**
20	65-90	75-100	65-100
12,5	52-76	60-86	47-78
8	40-63	45-73	30-58
4	26-45	31-54	14-37
2	15-32	20-40	0-15
0,5	7-21	9-24	0-6
0,25	4-16	5-18	0-4
0,063	0-9	0-9	0-2

In all those cases, the sieving by the 0,063 mm sieve (UNE-EN 933-2 Standard) will be less than two thirds (<2/3) of the sieving by the 0,250 mm sieve (UNE-EN 933-2 Standard) .

Table 20: Granulometry of the SR-SEL material

	SR-SEL	
SIEVES	**OPTION 1**	**OPTION 2**
# 20	>70%	
# 2		< 80%
# 0,4	≤ 15%	< 75%
# 0,08		<25%

In all those cases, the maximum particle size will be equal or lower to 100 mm

f) Geometric requirements

As indicated in the UNE-EN 933-5 and UNE-EN 933-3, the geometric requirements of the recycled aggregates from RCD are, for ZARHor and ZARM I, under a T3-T4 traffic category, the following (Table 21):

Table 21: Geometric requirements of the ZARHor and ZARM I materials

	ZARHor	ZARM I
Totally and partially crushed particles (%)	>50	>50
Fully rounded particles (%)	<10	<10
Flakiness index	<35	<35

g) Quality

The quality coefficient of the ZARHor and ZARM I stone material, as measured in the Los Angeles test and as indicated for granular layers in a T4 traffic category in the UNE-EN 1097-2, must be less than 40%.

h) Bearing capacity

As indicated in the UNE 10352, the post-saturation C.B.R. index for ZARHor and ZARM I will be higher than 40. Besides the swelling must be lower than 0,5%.

i) Plasticity

Although for ZARHor and ZARM I the UNE 103103 and the UNE 103104 do not specify (NP) neither the Liquid Limit (LL) nor the Plasticity Index (IP) of the fine material, the LL must be below 35 and the IP must be greater than 3 and less than or equal to 5. However, the aforementioned rule contemplates these values for the SR-SEL, which must be below 30 for the LL and below 10 for the IP

Besides of that, and as indicated in the UNE-EN 933-8 the sand equivalent (EA) must present the following values (Table 22):

Table 22: Sand equivalent for the ZARHor and ZARM I materials

	ZARHor	ZARM I
EA	>35	>70

However, these values may be decreased by 5 units as long as the methylene blue, as indicated in the UNE-EN 933-9, is less than 10.

j) Other physical-mechanical requirements

As indicated in the UNE-EN 933-1:2002, the absorption of the aggregates used in this project, depending on its particle size, must be the following (Table 23):

Table 23: Absorption requirements for ZARHor and ZARM I materials

Particle size (mm)	ZARHor	ZARM I
<4	<10%	<12%
>4	<7%	<9%

k) Chemical requirements

As indicated in the UNE 103204 the organic matter component of all the aggregates (ZARHor, ZARM I and SR-SEL) to be used in this project must be below 1%.

As indicated in the UNE-EN 1744-1, for ZARHor and ZARM I, the total sulfur (SO3) composition of the aggregates must be equal to 1,3%. Besides, and as mentioned in the aforementioned rule, the water-soluble sulfate content of recycled aggregate, expressed as SO3, must be below 0,7% and below 0,5% if the aggregates are in contact with concrete or cement.

As indicated in the UNE-EN 1367-2, for ZARHor and ZARM I, the mass loss in the sulfate stability test must be equal or lower to 18%

As indicated in NLT-114/99, for SR-SEL, the soluble salts content must be below 2%

As indicated in NLT-115, for SR-SEL, the plaster content must be below 2%

l) Quality control of the materials

The characteristics of the materials must be sampled prior to their work implementation, by the execution of the tests whose frequency and type are indicated below:

For every 500 m^3:

- A granulometric test.
- A determination of Atterberg Limits
- An EA test

For every 1000 m^3:

- A compaction test.

m) Execution of the works

Aggregates must be transported separately to the work and mixed, in the corresponding proportion, at the time of construction of the base.

In any case, the materials will be transported to the work taking over piles on the subgrade and with a separation between each of them proportionate to the volume of each pile and the volume of material to be extended by linear meter of country road.

The phases of commissioning work of the materials for the base are the following:

Firstly, the transport to the work of the materials already prepared in quarry, factory or plant or the separately. When transporting the aggregates, the necessary precautions will be taken to minimize segregation and humidity variations, if applicable. It will always be covered with suitable tarps or covers.

Secondly, before the initiation of the extension, the subgrade must be checked in order to make sure that it has the desired quality and shape. Besides of that, a trial section of, at least, 100 m will be carried out as indicated in the PG – 3 Article 510.6 in order to check that the process planned works correctly.

Thirdly, the initiation of the first extended with motor grader; at the same time the material will be watered until the optimum compaction humidity is reached. The regularity, the bearing capacity and the condition of the existing surface will be checked. The Special Technical Requirement Document, or in its absence the Work Director will indicate the measures aimed at reestablishing an acceptable surface regularity and, where appropriate, to repair the deficient areas. The thickness of each layer to be compacted will have the precise dimension so that, with the available media, the thickness and degree of compaction required are obtained throughout it, however it will not be in any case greater than 30 cm. All the water supply operations must take place before starting the compaction. Later, the only admissible one will be the one destined to achieve, on the surface, the humidity necessary for the execution of the following layer.

Finally, once the most suitable humidity has been obtained, which must comply with that specified in PG-3 Article 510.5.1, the layer will be compacted, which will continue until reaching the density specified in PG-3 Article 510.7.1. The compaction will be carried out according to the plan established in the Special Technical Requirement Document or approved by the Work Director, depending on the results of the test section. Compaction will be carried out continuously and systematically. If the extension is done by stripes, compacting one of them will expand the compaction area to include at least 15 cm from the previous one. The areas that, due to their reduced extension, slope or proximity to passage or drainage works, walls or structures, do not allow the use of the equipment that is normally used, will be compacted with adequate means, so that the densities that are reached they are not inferior, in any case, to those required in the rest of the layers.

The compaction must be carried out longitudinally, starting with the edges and overlapping, at each route, a width not less than one third of the compactor element width.

During this phase, possible irregularities of the profile must be corrected with motor grader.

Compaction operations will continue until 100% of Modified Proctor is reached. However, and as it is indicated in PG-3 Article 510.7.1, as the designed country road is under a T4 traffic

category, a density of not less than 98% of the Modified Proctor may be admitted by the Work Director.

If vibratory rollers are used, excessive vibration should be avoided in order to prevent the segregation of the materials

The base surface should be finished with 2% slopes on both sides of the country road and will be perfectly profiled, without undulations or irregularities, giving as a result a perfect crowned section.

Variations of 10% will be tolerated, in both more and less, of the thicknesses set in the corresponding work unit.

No new layer will be extended as long as they have been carried out, finding them compliant, the levelling checks and degrees of compaction.

The commissioning of materials when the temperature is below + 2ºC is prohibited.

The acceptance or rejection criteria of the finished unit will be applied to the lots defined in PG-3 Sections 510.9.3. and 510.10.

Any other operation not contemplated in this Requirement Document will be done based on Article 510 of the PG-3 or at the discretion of the Work Director.

n) Quality control

The execution of the works shall be monitored by carrying out the tests, whose frequency and type are indicated below, with the understanding that these figures are, in any case, minimal:

For every 250 m^3 of fraction of material used:

- A moisture determination.

For every 1000 m^2 or fraction of compacted layer:

- A density test.

For every 500 m of country road:

- A load plate test.

o) Measurement and payment

The work executed in accordance with the rules described above and those in the price chart and other project documents will be measured in meters (m) and paid.

3.4. SIGNALING, BEACONING AND DEFENSES

3.4.1. SIGNS AND RETROREFLECTIVE CIRCULATION VERTICAL SIGNS

a) Definition

Set of elements intended to inform, order or regulate the traffic by road or other types of ways, in which legends or pictogram are inscribed. The effectiveness of this visual information will also depend on its design facilitating the understanding of the message and its visibility distance, both day and night.

b) Materials

Vertical signs and posters of retroreflective circulation shall consist of a material used as a substrate, a substrate protection (painting, galvanizing, non-retroreflective sheet or other system), if necessary, to guarantee the durability of the substrate, on which a retroreflective material will be applied to the front. The assembly (signal or poster plates) shall be fixed to a support by appropriate anchors, and then proceeded to the installation of them on the path to be signaled.

Materials that meet the requirements for characteristics, durability, quality and service specified in the PG-3 articles shall be used for components of signals and vertical signs of retroreflecting circulation.

c) Support and anchorage

The signals supports and anchors will be in accordance with the implementation criteria and the dimensions of the current Rule 8.1 IC Vertical signaling.

d) Substrate

The substrate of vertical signs and posters of circulation shall comply with the UNE-EN 12899-1 Standard.

The dimensions, both of signs and posters as well as pictograms and letters, will be those indicated in the current Rule 8.1 IC Vertical signaling.

e) Accreditation of the materials

Compliance with the requirements for constituent materials shall be established by the presentation of the CE marking, which corresponds to each of the materials used in the manufacture and installation of vertical signs and signs of circulation. Such documentation shall include, for each material, the Manufacturer's Declaration of Performance as indicated in UNE-EN 12899-1 (table ZA.2 for the medium, table ZA.5 for substrate and table ZA.1 for retroreflecting materials of class RA1 and RA2).

f) Execution of the works

Before the beginning of the installation of vertical signs and signs of circulation, the Contractor shall submit to the approval of the Work Director the signaling systems for the traffic, personnel, materials and machinery protection during the period of implementation of the same.

Prior to the beginning of the work, careful setting-out will be carried out to ensure a completion of the work according to the specifications of the project.

The Work Director shall fix the installation procedure and the maximum time of opening to authorized traffic, as well as any other limitations on the execution defined in the project depending on the type of road, the location of the signs and posters, or any other significant circumstance that affected the quality and durability of the element or road safety.

Any other operation not contemplated in this Requirement Document will be done based on Article 701 of the PG-3 or at the discretion of the Work Director

g) Measurement and payment

Vertical circulation signals, including their station elements and anchors, shall be paid for units actually placed on work-site.

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº5: Measurements

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

In this document, the sizing and calculation of the different tasks and materials will be carried out in order to develop the current country road project. For this, each activity to be carried out will be detailed in chronological order along with the measurement unit indicated in the used Navarra´s forest fees price database.

For this, the Unit´s International System, in accordance with the UNE 82100 Standard, will be used.

The different operations and materials will be divided into five bigger chapters which will gather all the work units with similar characteristics. Those chapters are the following:

- Chapter 1. Earthworks
- Chapter 2. Drains
- Chapter 3. Pavement
- Chapter 4. Signaling, beaconing and defenses
- Chapter 5: Waste management

2. MEASUREMENTS CHARTS

Code	Units	Description	Amount

CHAPTER 1.- EARTHWORKS

NDBQ11 ha **Clearing and topsoil removal; slope <=10%; mean difference/FCC>50 and <=80%.**

Mechanized clearing on land with a slope of less than or equal to 10%. Covered cover fraction (FCC) of more than 50 and less than or equal to 80% and / or medium difficulty of the scrub to be processed. Elimination of all types of vegetation and vegetation remains, and clearing of topsoil, with a thickness of 30 cm. Including transportation to outside the occupancy area of the work, at a maximum distance of 20 m.

Total ha: 4

NIFA0103 m^3 **Cut excavation and transportation to fill area, transit terrain.**

Cut excavation and transport to fill area in transit terrain. Maximum transport distance 50 m.

Total m^3: 27000

NIFA0105 m^3 **Fill construction, unclassified land.**

Fill construction on unclassified terrain, layered according to the capacity of the team and the nature of the terrain. Maximum required density of 100% of the Modified Proctor Test.

Total m^3: 19000

NIFA0406 m^3 **Gutter excavation; transit terrain land.**

Gutter excavation up to 50 cm deep, in light or free terrain. Even profiling of slopes and refining of slopes. Expressed in m^3 of excavation per linear meter.

Total m^3: 975,2

NIFO01 m^2 **Cuts and fills hydroseeding**

Hydroseeding in slopes, based on a first pass with 300 kg / ha of grass seeds, 30 kg / ha of woody seeds, 1,000 kg / ha of controlled release fertilizer, 500 kg / ha of mechanical cellulose, 200 kg / ha of shredded straw, 50 kg / ha of water-absorbent polymer and 120 kg / ha of polybutadiene-type stabilizer, immediately covered with 500 kg / ha of mechanical cellulose, 100 kg / ha of shredded straw and 80 kg / ha of polybutadiene-type stabilizer .

Total m^2: 15000

Code	Units	Description	Amount

CHAPTER 2.- DRAINS

NIFO01 ud **Reinforced concrete 400 mm diameter pipe; convenient access; transit land.**

Single reinforced concrete bell pipe (with HA-30/S/20IIb concrete and B500S reinforcement and 400mm of inner diameter of 2,4 m in length (useful length) (2,5 m in total length) and with spear joint, (includes acquisition and transportation from the factory to the construction site in good access conditions and the sealing ring) according to UNE-EN 1916:2008. It includes, when necessary, trench excavation in loam or traffic type terrain, distribution and unloading of materials, as well as the placement of pipes using mechanical means. Includes trench filling with previously excavated materials and spreading of the rest, according to typified work until perfect completion of the works. It does not include wingwalls or wells.

Total ud: 89

NIFO21 ud **Well construction for a 400 mm diameter pipe; transit terrain.**

Well construction for a single or double pipe with a 400-inner diameter, with HA-20/S/20/IIb mass concrete, coming from the plant. It will have a maximum depth of 1,24 m, 20 cm thick walls, 20cm of foundation and 10cm of over-excavation filled with lean concrete, it will be internally and externally reinforced with a 15/15/8 electro welded construction mesh with 5cm coating on either sides and will be covered with a steel grating lid. It includes excavation in free or transit-type terrain, formwork, reinforcement placement, pouring and stripping works until the works are completed.

Total ud: 15

NIFO026 ud **Wingwalls construction for a 400 mm diameter pipe; transit terrain**

Wingwalls for a single spout with an inner diameter of 400 mm, with 2 lateral fins (27 cm thick), constructed with HM-20 mass concrete (20 mm maximum aggregate) internally and externally reinforced with a 15/15/8 electro welded construction mesh with 5 cm coating on either and 20 cm deep foundation in addition to the 10 cm of over-excavation filled with lean concrete. It includes excavation in free or transit-type terrain, formwork, reinforcement placement, pouring and stripping works until the works are completed.

Total ud: 14

Code	Units	Description	Amount

CHAPTER 3.- PAVEMENT

NIFVE0104 m **Pavement construction**

Linear meter of pavement construction over the subgrade. Includes the extension layer by layer of the granular material and compaction up to 100% of the Modified Proctor Test, including irrigation with water until the specified humidity is reached, of the 30 cm of Recycled RCD selected soil, 20 cm of Mixed recycled artificial ballast type I and 20 cm of concrete recycled artificial ballast. The granular materials are included in this work unit.

Total m: 2254,5

Code	Units	Description	Amount

CHAPTER 4.- SIGNALING, BEACONING AND DEFENSES

NIFO01 ud **Placement of 70 cm side or 60 cm diameter triangular or circular sign.**

Placement of a prohibition, restriction or obligation sign, reflective, triangular or circular in shape and 70 cm of side or 60 cm in diameter respectively, including the support pole, screws, excavation and concreting.

Total ud: 2

Code	Units	Description	Amount

CHAPTER 5.- WASTE MANAGEMENT

NGTB020 m^3 **Land transportation with truck and dumping fee for delivery to waste manager**

Transport by truck of the products from the excavation of any type of land to a specific landfill or construction waste treatment facility , located at a maximum distance of 10 km. The price includes the waiting time on site during loading operations, the outward journey, the unloading and the return journey and the dumping fee for delivery of land from the excavation, in specific landfill or construction waste treatment facility.

Total m^3: 8000

NGRB020 m^3 **Transportation of inert waste by truck and delivery to authorized manager.**

Transport by truck of inert wastes produced in the work, to a specific landfill or construction waste treatment located 10 km away . The price includes the waiting time on site during loading operations, the outward journey, the unloading and the return journey and the dumping fee for delivery of the produced inert wood waste in a specific landfill or construction waste treatment facility

Total m^3: 5

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº6: Budget

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

This document will try to quantify the cost that the construction of the country road will suppose, valuing all the aspects that are involved in it.

In order to increase the understanding of this document, as it has been done in the Measurements Document, the operations will be divided into five chapters that correspond to the following:

- Chapter 1. Earthworks
- Chapter 2. Drains
- Chapter 3. Pavement
- Chapter 4. Signaling, beaconing and defenses
- Chapter 5: Waste management

2. PRICE CHARTS Nº1

Code	Units	Description	Price (€)

CHAPTER 1.- EARTHWORKS

NDBQ11 ha **Clearing and topsoil removal; slope <=10%; mean difference/FCC>50 and <=80%.**

Mechanized clearing on land with a slope of less than or equal to 10%. Covered cover fraction (FCC) of more than 50 and less than or equal to 80% and / or medium difficulty of the scrub to be processed. Elimination of all types of vegetation and vegetation remains, and clearing of topsoil, with a thickness of 30 cm. Including transportation to outside the occupancy area of the work, at a maximum distance of 20 m.

€/ha: 590,78

NIFA0103 m^3 **Cut excavation and transportation to fill area, transit terrain.**

Cut excavation and transport to fill area in transit terrain. Maximum transport distance 50 m.

€/m^3: 1,25

NIFA0105 m^3 **Fill construction, unclassified land.**

Fill construction on unclassified terrain, layered according to the capacity of the team and the nature of the terrain. Maximum required density of 100% of the Modified Proctor Test.

€/m^3: 0,68

NIFA0406 m^3 **Gutter excavation; transit terrain land.**

Gutter excavation up to 50 cm deep, in light or free terrain. Even profiling of slopes and refining of slopes. Expressed in m^3 of excavation per linear meter.

€/m^3: 5,15

NIFO01 m^2 **Cuts and fills hydroseeding**

Hydroseeding in slopes, based on a first pass with 300 kg / ha of grass seeds, 30 kg / ha of woody seeds, 1,000 kg / ha of controlled release fertilizer, 500 kg / ha of mechanical cellulose, 200 kg / ha of shredded straw, 50 kg / ha of water-absorbent polymer and 120 kg / ha of polybutadiene-type stabilizer, immediately covered with 500 kg / ha of mechanical cellulose, 100 kg / ha of shredded straw and 80 kg / ha of polybutadiene-type stabilizer .

€/m^2: 1,7

Code	Units	Description	Price (€)

CHAPTER 2.- DRAINS

NIFO01 ud **Reinforced concrete 400 mm diameter pipe; convenient access; transit land.**

Single reinforced concrete bell pipe (with HA-30/S/20IIb concrete and B500S reinforcement and 400mm of inner diameter of 2,4 m in length (useful length) (2,5 m in total length) and with spear joint, (includes acquisition and transportation from the factory to the construction site in good access conditions and the sealing ring) according to UNE-EN 1916:2008. It includes, when necessary, trench excavation in loam or traffic type terrain, distribution and unloading of materials, as well as the placement of pipes using mechanical means. Includes trench filling with previously excavated materials and spreading of the rest, according to typified work until perfect completion of the works. It does not include wingwalls or wells.

€/m: 62,281

NIFO21 ud **Well construction for a 400 mm diameter pipe; transit terrain.**

Well construction for a single or double pipe with a 400-inner diameter, with HA-20/S/20/IIb mass concrete, coming from the plant. It will have a maximum depth of 1,24 m, 20cm thick walls, 20cm of foundation and 10cm of over-excavation filled with lean concrete, it will be internally and externally reinforced with a 15/15/8 electro welded construction mesh with 5cm coating on either sides and will be covered with a steel grating lid. It includes excavation in free or transit-type terrain, formwork, reinforcement placement, pouring and stripping works until the works are completed.

€/ud: 480

NIFO026 ud **Wingwalls construction for a 400 mm diameter pipe; transit terrain**

Wingwalls for a single spout with an inner diameter of 400 mm, with 2 lateral fins (27 cm thick), constructed with HM-20 mass concrete (20 mm maximum aggregate) internally and externally reinforced with a 15/15/8 electro welded construction mesh with 5 cm coating on either and 20 cm deep foundation in addition to the 10 cm of over-excavation filled with lean concrete. It includes excavation in free or transit-type terrain, formwork, reinforcement placement, pouring and stripping works until the works are completed.

€/ud: 153,31

Code	Units	Description	Price (€)

CHAPTER 3.- PAVEMENT

NIFVE0104 m **Pavement construction**

Linear meter of pavement construction over the subgrade. Includes the extension layer by layer of the granular material and compaction up to 100% of the Modified Proctor Test, including irrigation with water until the specified humidity is reached, of the 30 cm of Recycled RCD selected soil, 20 cm of Mixed recycled artificial ballast type I and 20 cm of concrete recycled artificial ballast. The granular materials are included in this work unit.

€/m: 16,46

Code	Units	Description	Price (€)

CHAPTER 4.- SIGNALING, BEACONING AND DEFENSES

NIFO01 ud **Placement of 70 cm side or 60 cm diameter triangular or circular sign.**

Placement of a prohibition, restriction or obligation sign, reflective, triangular or circular in shape and 70 cm of side or 60 cm in diameter respectively, including the support pole, screws, excavation and concreting.

€/ud: 155,1

Code	Units	Description	Price (€)

CHAPTER 5.- WASTE MANAGEMENT

NGTB020 m^3 **Land transportation with truck and dumping fee for delivery to waste manager**

Transport by truck of the products from the excavation of any type of land to a specific landfill or construction waste treatment facility , located at a maximum distance of 10 km. The price includes the waiting time on site during loading operations, the outward journey, the unloading and the return journey and the dumping fee for delivery of land from the excavation, in specific landfill or construction waste treatment facility.

€/m^3: 4,5

NGRB020 m^3 **Transportation of inert waste by truck and delivery to authorized manager.**

Transport by truck of inert wastes produced in the work, to a specific landfill or construction waste treatment located 10 km away . The price includes the waiting time on site during loading operations, the outward journey, the unloading and the return journey and the dumping fee for delivery of the produced inert wood waste in a specific landfill or construction waste treatment facility

€/m^3: 15,03

3. PRICE CHARTS Nº2

Code	Units	Description	Price (€)

CHAPTER 1.- EARTHWORKS

NDBQ11 ha **Clearing and topsoil removal; slope <=10%; mean difference/FCC>50 and <=80%.**

Mechanized clearing on land with a slope of less than or equal to 10%. Covered cover fraction (FCC) of more than 50 and less than or equal to 80% and / or medium difficulty of the scrub to be processed. Elimination of all types of vegetation and vegetation remains, and clearing of topsoil, with a thickness of 30 cm. Including transportation to outside the occupancy area of the work, at a maximum distance of 20m.

WITHOUT BREAKDOWN

NIFA0103 m^3 **Cut excavation and transportation to fill area, transit terrain.**

Cut excavation and transport to fill area in transit terrain. Maximum transport distance 50 m.

WITHOUT BREAKDOWN

NIFA0105 m^3 **Fill construction, unclassified land.**

Fill construction on unclassified terrain, layered according to the capacity of the team and the nature of the terrain. Maximum required density of 100% of the Modified Proctor Test.

WITHOUT BREAKDOWN

NIFA0406 m^3 **Gutter excavation; transit terrain land.**

Gutter excavation up to 50 cm deep, in light or free terrain. Even profiling of slopes and refining of slopes. Expressed in m^3 of excavation per linear meter.

WITHOUT BREAKDOWN

NIFO01 m^2 **Cuts and fills hydroseeding**

Hydroseeding in slopes, based on a first pass with 300 kg / ha of grass seeds, 30 kg / ha of woody seeds, 1,000 kg / ha of controlled release fertilizer, 500 kg / ha of mechanical cellulose, 200 kg / ha of shredded straw, 50 kg / ha of water-absorbent polymer and 120 kg / ha of polybutadiene-type stabilizer, immediately covered with 500 kg / ha of mechanical cellulose, 100 kg / ha of shredded straw and 80 kg / ha of polybutadiene-type stabilizer .

WITHOUT BREAKDOWN

Code	Units	Description	Price (€)

CHAPTER 2.- DRAINS

NIFO01 ud **Reinforced concrete 400 mm diameter pipe; convenient access; transit land.**

Single reinforced concrete bell pipe (with HA-30/S/20IIb concrete and B500S reinforcement and 400mm of inner diameter of 2,4 m in length (useful length) (2,5 m in total length) and with spear joint, (includes acquisition and transportation from the factory to the construction site in good access conditions and the sealing ring) according to UNE-EN 1916:2008. It includes, when necessary, trench excavation in loam or traffic type terrain, distribution and unloading of materials, as well as the placement of pipes using mechanical means. Includes trench filling with previously excavated materials and spreading of the rest, according to typified work until perfect completion of the works. It does not include wingwalls or wells.

WITHOUT BREAKDOWN

NIFO21 ud **Well construction for a 400 mm diameter pipe; transit terrain.**

Well construction for a single or double pipe with a 400-inner diameter, with HA-20/S/20/IIb mass concrete, coming from the plant. It will have a maximum depth of 1,24 m, 20 cm thick walls, 20 cm of foundation and 10 cm of over-excavation filled with lean concrete, it will be internally and externally reinforced with a 15/15/8 electro welded construction mesh with 5cm coating on either sides and will be covered with a steel grating lid. It includes excavation in free or transit-type terrain, formwork, reinforcement placement, pouring and stripping works until the works are completed.

WITHOUT BREAKDOWN

NIFO026 ud **Wingwalls construction for a 400 mm diameter pipe; transit terrain**

Wingwalls for a single spout with an inner diameter of 400 mm, with 2 lateral fins (27 cm thick), constructed with HM-20 mass concrete (20 mm maximum aggregate) internally and externally reinforced with a 15/15/8 electro welded construction mesh with 5 cm coating on either and 20 cm deep foundation in addition to the 10 cm of over-excavation filled with lean concrete. It includes excavation in free or transit-type terrain, formwork, reinforcement placement, pouring and stripping works until the works are completed.

WITHOUT BREAKDOWN

Code	Units	Description	Price (€)

CHAPTER 3.- PAVEMENT

NIFVE0104 m **Pavement construction**

Linear meter of pavement construction over the subgrade. Includes the extension layer by layer of the granular material and compaction up to 100% of the Modified Proctor Test, including irrigation with water until the specified humidity is reached, of the 30 cm of Recycled RCD selected soil, 20 cm of Mixed recycled artificial ballast type I and 20 cm of concrete recycled artificial ballast. The granular materials are included in this work unit.

WITHOUT BREAKDOWN

Code	Units	Description	Price (€)

CHAPTER 4.- SIGNALING, BEACONING AND DEFENSES

NIFO01 ud **Placement of 70 cm side or 60 cm diameter triangular or circular sign.**

Placement of a prohibition, restriction or obligation sign, reflective, triangular or circular in shape and 70 cm of side or 60 cm in diameter respectively, including the support pole, screws, excavation and concreting.

WITHOUT BREAKDOWN

Code	Units	Description	Price (€)

CHAPTER 5.- WASTE MANAGEMENT

NGTB020 m^3 **Land transportation with truck and dumping fee for delivery to waste manager**

Transport by truck of the products from the excavation of any type of land to a specific landfill or construction waste treatment facility , located at a maximum distance of 10 km. The price includes the waiting time on site during loading operations, the outward journey, the unloading and the return journey and the dumping fee for delivery of land from the excavation, in specific landfill or construction waste treatment facility.

WITHOUT BREAKDOWN

NGRB020 m^3 **Transportation of inert waste by truck and delivery to authorized manager.**

Transport by truck of inert wastes produced in the work, to a specific landfill or construction waste treatment located 10 km away . The price includes the waiting time on site during loading operations, the outward journey, the unloading and the return journey and the dumping fee for delivery of the produced inert wood waste in a specific landfill or construction waste treatment facility

WITHOUT BREAKDOWN

4. PARTIAL BUDGET

Code	Units	Description	Amount	Unit price (€)	Full amount (€)
CHAPTER 1.- EARTHWORKS					
NDBQ11	ha	**Clearing and topsoil removal; slope <=10%; mean difference/FCC>50 and <=80%.**			
		Mechanized clearing on land with a slope of less than or equal to 10%. Covered cover fraction (FCC) of more than 50 and less than or equal to 80% and / or medium difficulty of the scrub to be processed. Elimination of all types of vegetation and vegetation remains, and clearing of topsoil, with a thickness of 30 cm. Including transportation to outside the occupancy area of the work, at a maximum distance of 20 m.			
			4	590,78	
				Total:	2363,12
NIFA0103	m^3	**Cut excavation and transportation to fill area, transit terrain.**			
		Cut excavation and transport to fill area in transit terrain. Maximum transport distance 50 m.			
			27000	1,25	
				Total:	33750
NIFA0105	m3	**Fill construction, unclassified land.**			
		Fill construction on unclassified terrain, layered according to the capacity of the team and the nature of the terrain. Maximum required density of 100% of the Modified Proctor Test.			
			19000	0,68	
				Total:	12920
NIFA0406	m^3	**Gutter excavation; transit terrain land.**			
		Gutter excavation up to 50 cm deep, in light or free terrain. Even profiling of slopes and refining of slopes. Expressed in m³ of excavation per linear meter.			
			975,2	5,15	
				Total:	5022,28

Code	Units	Description	Amount	Unit price (€)	Full amount (€)
CHAPTER 1.- EARTHWORKS					
NIFO01					
	m^2	**Cuts and fills hydroseeding** Hydroseeding in slopes, based on a first pass with 300 kg / ha of grass seeds, 30 kg / ha of woody seeds, 1,000 kg / ha of controlled release fertilizer, 500 kg / ha of mechanical cellulose, 200 kg / ha of shredded straw, 50 kg / ha of water-absorbent polymer and 120 kg / ha of polybutadiene-type stabilizer, immediately covered with 500 kg / ha of mechanical cellulose, 100 kg / ha of shredded straw and 80 kg / ha of polybutadiene-type stabilizer .			
			15000	1,7	
				Total:	25500
			Total Chapter 1:		79555,4

Code	Units	Description	Amount	Unit price (€)	Full amount (€)
CHAPTER 2.- DRAINS					
NIFO01	ud	**Reinforced concrete 400 mm diameter pipe; convenient access; transit land.**			
		Single reinforced concrete bell pipe (with HA-30/S/20IIb concrete and B500S reinforcement and 400mm of inner diameter of 2,4 m in length (useful length) (2,5 m in total length) and with spear joint, (includes acquisition and transportation from the factory to the construction site in good access conditions and the sealing ring) according to UNE-EN 1916:2008. It includes, when necessary, trench excavation in loam or traffic type terrain, distribution and unloading of materials, as well as the placement of pipes using mechanical means. Includes trench filling with previously excavated materials and spreading of the rest, according to typified work until perfect completion of the works. It does not include wingwalls or wells.			
			89	62,281	
				Total:	5543,009
NIFO21	ud	**Well construction for a 400 mm diameter pipe; transit terrain.**			
		Well construction for a single or double pipe with a 400- inner diameter, with HA-20/S/20/IIb mass concrete, coming from the plant. It will have a maximum depth of 1,24 m, 20 cm thick walls, 20 cm of foundation and 10cm of over-excavation filled with lean concrete, it will be internally and externally reinforced with a 15/15/8 electro welded construction mesh with 5 cm coating on either sides and will be covered with a steel grating lid. It includes excavation in free or transit-type terrain, formwork, reinforcement placement, pouring and stripping works until the works are completed.			
			15	480	
				Total:	7200
NIFO026	ud	**Wingwalls construction for a 400 mm diameter pipe; transit terrain**			
		Wingwalls for a single spout with an inner diameter of 400mm, with 2 lateral fins (27 cm thick), constructed with HM-20 mass concrete (20 mm maximum aggregate) internally and externally reinforced with a 15/15/8 electro welded construction mesh with 5cm coating on either and 20 cm deep foundation in addition to the 10 cm of over-excavation filled with lean concrete. It includes excavation in free or transit-type terrain, formwork, reinforcement placement, pouring and stripping works until the works are completed.			
			14	153,31	
				Total:	2146,34
				Total Chapter 2:	14889,349

Code	Units	Description	Amount	Unit price (€)	Full amount (€)
CHAPTER 3.- PAVEMENT					
NIFVE0104	m	**Pavement construction** Linear meter of pavement construction over the subgrade. Includes the extension layer by layer of the granular material and compaction up to 100% of the Modified Proctor Test, including irrigation with water until the specified humidity is reached, of the 30cm of Recycled RCD selected soil, 20 cm of Mixed recycled artificial ballast type I and 20 cm of concrete recycled artificial ballast. The granular materials are included in this work unit.	2254,5	16,46	
				Total:	37109,07
			Total Chapter 3:		37109,07

Code	Units	Description	Amount	Unit price (€)	Full amount (€)
CHAPTER 4.- SIGNALING, BEACONING AND DEFENSES					
NIFO01	ud	**Placement of 70 cm side or 60 cm diameter triangular or circular sign.** Placement of a prohibition, restriction or obligation sign, reflective, triangular or circular in shape and 70 cm of side or 60 cm in diameter respectively, including the support pole, screws, excavation and concreting.	2	155,1	
				Total:	310,2
				Total Chapter 4:	310,2

Code	Units	Description	Amount	Unit price (€)	Full amount (€)
CHAPTER 5.- WASTE MANAGEMENT					
NGTB020	m^3	**Land transportation with truck and dumping fee for delivery to waste manager** Transport by truck of the products from the excavation of any type of land to a specific landfill or construction waste treatment facility , located at a maximum distance of 10 km. The price includes the waiting time on site during loading operations, the outward journey, the unloading and the return journey and the dumping fee for delivery of land from the excavation, in specific landfill or construction waste treatment facility.	8000	4,5	
				Total:	36000
NGRB020	m^3	**Transportation of inert waste by truck and delivery to authorized manager.** Transport by truck of inert wastes produced in the work, to a specific landfill or construction waste treatment located 10 km away . The price includes the waiting time on site during loading operations, the outward journey, the unloading and the return journey and the dumping fee for delivery of the produced inert wood waste in a specific landfill or construction waste treatment facility	5	15,03	
				Total:	75,15
				Total Chapter 5:	36075,15

5. SUMMARY BUDGET

Chapter	Full amount (€)
SUMMARY BUDGET	
MATERIAL EXECUTION BUDGET (PEM)	
CHAPTER 1.- EARTHWORKS	79555,400
CHAPTER 2.- DRAINS	14889,349
CHAPTER 3.- PAVEMENT	37109,070
CHAPTER 4.- SIGNALING, BEACONING AND DEFENSES	310,200
CHAPTER 5.- WASTE MANAGEMENT	36075,15
SAFETY AND HEALTH	20000,000
TOTAL PEM	187939,169
CONTRACT EXECUTION BUDGET (PEC)	
10% OVERHEAD COSTS	18793,9169
6% INDUSTRIAL PROFIT	11276,35014
TOTAL PEC	218009,436
GENERAL BUDGET	
21% IVA	45781,98157
TOTAL GENERAL BUDGET	263791,42

The works object of the "Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)" project have a total budget amounting to TWO HUNDRED AND SIXTY-THREE THOUSAND SEVEN HUNDRED AND NINTY-ONE euros with FOURTY-TWO cents (263791,42 €), including IVA.

Pamplona, May 2020.

The project maker
SGD: Asier Gamallo Valls

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº7: Environmental Effects Assessment

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

In application of the Intervention for the Environmental Protection of Navarra Foral Law 4/2005, of March 22nd, and the Regulations that develops it in detail, the Foral Decree 96/2006, of December 28th, this project is subjected to Environmental Effects Authorization, as it is included in the group of 'Opening and modification of new permanent roads and tracks with a length greater than 100 linear meters, widening and improvement of roads in an extension of less than 10 kilometers 'projects or activities.

2. RESOLUTION AND AUTHORIZATION

No previous facultative report is required. The lack of resolution and notification within the established four-month period would have dismissal effects. The Environmental Effects Authorization would expire if the execution of the project had not started within two years.

3. OBJECT

The aim of the current Environmental Effects Assessment will be to obtain the environmental effects authorization. For that purpose, this study will be carried out according to the guidelines given in the Art.34 of the DF 96/2006.

4. PROJECT OR ACTION DESCRIPTION

The project for which the Environmental Effects Authorization is requested consists of the construction of a country road which will connect the Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra).

This country road will start in the (627327,57N, 4701613,20E) point, placed in Murillo el Fruto I country road and will end in the (626586,00N, 4701845,71E) point, placed in the country road that goes across Lakumulatu area. Along all its way, the designed country road will be constructed over four different plots. The data of those plots can be checked in the Table 24.

Table 24: Affected plots data

	Agricultural Plot	Agricultural estate	Affected surface (m^2)	Use	Class
Expropriation 1	191	18	34040,9091	Forest rangeland	3

	Agricultural Plot	Agricultural estate	Affected surface (m^2)	Use	Class
Expropriation 2	252	18	1779,2486	Forest rangeland	3
Expropriation 3	227	18	2478,0241	Forest rangeland	3
Expropriation 4	140	18	1735,5609	Forest rangeland	3

As the designed country road will be constructed over a steeply and hilly terrain, a great deal of earthworks will be needed. For this reason, the Lakumulatu´s hillside terrain will be severely modified. These modifications can be checked, analyzed and studied in the Plans Nº6 and Nº2.

All the land to be used in the fills will come from the excavation of the work itself, however, not all the extracted material from the excavation will go to the fills. That surplus material will be directly transported to an authorized landfill at the time they are excavated.

As far as the final destination of the land after the activity closure, taking into account that the designed project is a country road for public use, it is considered that it will have an unlimited life. It is possible that in distant future this country road may undergo repairs and/or modifications

The works for the country road construction will start on September 7th, 2020 and will end on November 19th, 2020.

5. EXISTING ALTERNATIVES DESCRIPTION

Among all the alternatives that were studied and considering that the main objective was to communicate the two pre-existing country roads in order to reduce the distance of the Lakumulatu agricultural area to the closest villages, the one that was chosen was the most suitable one. The other studied alternatives involved the permanent occupation of larger area and more agricultural plots, the modification of the pre-existing country roads axis, the earthwork volume increasement and its subsequent increase in visual impact, a larger area to clear, etc. For that reason and taking into account the requirements imposed for this project, the actual drafting was selected.

6. ENVIRONMENTAL AND ECOLOGICAL IDENTIFICATION OF THE AFFECTED VALUES

The environmental and values that can be affected by the project actions, corresponding to the inert, biotic and socioeconomic environments, are:

- Inert environment:
    - Relief: The Lakumulatu´s hillside relief will be modified after the construction of the designed country road, which will be made by a 4m wide crowned section, a 3/2 cut slope (in most cases), a 2/1 fill slope (in most cases) and a 1,4 m wide gutter between the pavement and the cuts sections.
    - Farming capacity: The country road´s structure will occupy a portion of the Lakumulatu´s hillside land and will compact it.
    - Erosion: The construction of the designed country road will leave some areas uncovered by plants, which may lead to an erosion increasement in those areas.
    - Surface waters: Since the topography of the area is going to change with the construction of the country road, the natural drainage network will be modified.
    - Air quality: The designed country road will reduce quite a lot the distance from the Lakumulatu agricultural area to the closest villages, and consequently, the polluting emissions.
    - Landscape: With the modification of the relief provoked by the earthworks, the landscape of the Lakumulatu´s hillside will be seriously modified.

- Biotic environment:
    - Vegetation: In the Lakumulatu´s hillside scrub vegetation predominated. With the construction of the country road a large area will be cleared.
    - Wildlife: A large number of wild animals live in the Ujué area, such as: wild pigs, Iberian hares, foxes, Mediterranean voles, partridges, kites, etc.

- Socioeconomics environment:
    - Social welfare: The designed country road will reduce quite a lot the distance from the Lakumulatu agricultural area to the closest villages, and consequently, the time lost by farmers driving.
    - Economic activities: The purpose of Lakumulatu area, and most of its surroundings, is the agriculture.

7. FORSEEABLE ENVIRONMENTAL EFFECTS IDENTIFICATION

The projected country road will produce the following effects:

- Construction phase:
    - Topsoil removal
    - Earthworks
    - Pavement and secondary structures construction
    - Land occupancy
    - Noise, gases and dust emission
    - Excavated land surplus generation
    - Waste generation

- Operating phase
    - Noise emission
    - Barriers to wildlife

- Abandonment phase
    - Earthworks
    - Noise, gases and dust emission
    - Waste generation

8. ENVIRONMENTAL EFFECTS EVALUATION

The effects that will be produced by the designed country road can be classified according to the need to apply corrective, compensatory or preventive measures. According to this classification, the impact types can be classified into four different groups: critical, severe, moderate and compatible. However, since the impacts are intense but their dimension is very small, only two types of impacts will be found: moderate and compatible. It will be classified as moderate when, to minimize the damage caused by the work operations, they do not require intensive measures and the results of this application occur in the short term. In the case of a compatible impacts, they do not require the use of protective or corrective practices, since once the activity ends, the recovery of the environment is immediate.

In the construction phase different impacts will be produced. These impacts are detailed below. In the first place in order to construct the country road the topsoil will be needed to be removed. This fact will affect to the biotic media, as a there will be a loss of land for vegetation and to host life of different organisms without any landscape, botanical or biological interest. As a consequence of that, there will be an increasement in the hillside erosion and a decrease in the farming capacity. In the second place, due to the hilly terrain over which the country road is going to be built, a great deal of earthworks will be needed to be carried out. This fact will produce a very remarkable impact in the area, since apart from breaking the landscape of the hillside and causing a great visual impact, the natural drainage network of the area will be broken due to the construction of fills and cuts, which at the same time will increase the erosion of the area. In the third place the construction of the pavement and other secondary structures will produce a reduction of the permeable surface of the area, which will also affect to the natural drainage system of the hillside. In the fourth place, due to the large amount of surface that the country road will cover, there will be a reduction of both the surface with farming capacity and the surface occupied by the potential vegetation of the area, which is scrub vegetation without any type of landscape or botanical interest. In the fifth place, due to the work carried out by machinery and by the different trucks that circulate in the surroundings, not only a lot of dust raising, and a higher noise than the one that the area usually presents will be generated, but it may also affect to the people working in the surroundings. In the sixth place, since the land on which it is going to be carried out the construction is very steep and rough, the amount of land to be excavated will be much greater than the land to be used in the work itself. This will

force to take this surplus, together to other generated wastes (wood in most cases), to an authorized landfill to avoid problems from waste generation point of view, however, they may cause an impact on the landscape when they are stored on the site.

As far as the operation phase, two impacts will be mainly produced with the continuous use of the constructed country road. Those two impacts are described below. In the first place, as the traffic of agricultural vehicles in that area increases, the noise will increase dramatically, affecting in some way to the farmers of the area. In the second place, due to the presence of cuts and fills, wildlife may have some troubles to go from one side to the other.

In the abandonment phase different impacts will be produced, which are detailed below. In the first place, as the hillside where the country road will be settled will have to be recovered, earthworks will be needed. That operation will directly affect to the relief of the area and to the socioeconomic environment. In the second place, due to the activities that will be carried out in this phase, noise, gases and dust emissions will occur, affecting in this way not only to the air quality but also to the social welfare of the farmers of the surroundings. Finally, as a result of this operations, a certain amount of wastes will be generated, affecting in some way to the landscape of the area while they are stored on the site.

The impacts that will occur in all the phases in all the considered environmental and ecological values are showed the Leopold Matrix (Figure 6).

		CONSTRUCTION PHASE							OPERATING PHASE		ABANDONMENT PHASE		
		Top soil removal	Earthworks	Pavement and secondary structures construction	Land occupancy	Noise, gases and dust emissions	Excavated land surplus generation	Waste generation	Noise emissions	Barriers to wildlife	Earthworks	Noise, gases and dust emissions	Waste generation
INERT ENVIRONMENT	Relief												
	Farming capacity												
	Erosion												
	Surface waters												
	Air quality												
	Landscape												
BIOTIC ENVIRONMENT	Vegetation												
	Wildlife												
SOCIO-ECONOMIC ENVIORNMENT	Social welfare												
	Economic activities												

Compatible impacts
Moderate impacts

Figure 6: Resulting Leopold Matrix before the measures implementation

9. PROTECTIVE AND CORRECTIVE ACTIONS

In the current point the actions to minimize the negative impacts generated by the construction of the designed rural road are going to be defined. These will be economically viable with the project´s dimensions and magnitude so they can be easily implemented to mitigate the impacts and effects.

9.1.PREVENTIVE ACTIONS

The objective of these measures will be to prevent possible negative impacts.

- Good practices on the work: They largely depend on the Contractor and among them are the daily working schedule, the watering of the roads to avoid dust-raising, the respect for the surroundings, etc.
- Waste management plan: Mainly it tries that all the waste and rubbish generated in the work are managed correctly.
- Equipment maintenance. The main aim is to prevent the polluting substances discharge from leaks.
- Signaling: It consists of the installation of vertical signs that warn us of possible dangers.
- Wildlife-friendly rural infrastructure: In order to avoid troubles in the wildlife, the country road will not have any fence that could affect to the transit of the animals. Moreover, all the wells will have a tramex panel lid in order to prevent falls.

9.2.CORRECTIVE ACTIONS

The objective of these measures will be to minimize the negative impacts that occur as a consequence of some of the activities carried out in any of the phases of the project.
º

- Slopes revegetation with hydroseeding: In this way erosion will be avoided, the vegetation cover will be recovered and the visual impact of the slopes of the natural environment will be considerably reduced.
- Drainage system construction: In this way the loss of permeable surface will be corrected with the incorporation of gutters, wells, cross drains, etc. Besides, as the natural drainage network will be broken, this system will help to rebuild a network to affect as little as possible the country road and the entire hillside where it will be settled.

Given the local effect and the small magnitude produced by the various activities and operations that will result from this project, it is considered that, after the correct implementation of the aforementioned measures, all the impacts produced are nullified or compatible.

10.PEOPLE INTERESTED IN THE PROJECT

The farmers of the Ujué's Agricultural state nº18, corresponding to the Lakumulatu area, will be the ones more interested in this project as the access to many of their plots will be much more accessible and faster through this country road

11.ENVIRONMENTAL MONITORING PROGRAM

The environmental monitoring program during the construction phase will be carried out by the Work Director, who will be in charge of taking the aforementioned actions and preventing other impacts or effects on the environment. However, during the operation and abandonment phase of this project, the competent authorities of the area will be in charge of carrying out the environmental monitoring program.

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Document Nº8: Basic Safety and Health Report

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

In compliance with R.D. 1627/97 of October 24th (Art. 7.1), this Basic Safety and Health Report has been developed for country road construction works, aiming to define the guidelines contained in this project

Adapting to what is exposed in Article 16 of Law 31/95 of November 8th on the Prevention of Occupational Risks.

Taking into account the 'Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)' project, the current Basic Safety and Health Report will describe the technical measures and preventive standards to be applied during the course of the work.

The project maker
Sgd: Asier Gamallo Valls

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Information Report

-BASIC SAFETY AND HEALTH REPORT -

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. COMMISSION DATA

1.1.PROJECT NAME

Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)'

1.2.LOCATION

The designed country road, in Ujué (Navarra) will start in the (627327,57N, 4701613,20E) point, placed in Murillo el Fruto I country road and will end in the (626586,00N, 4701845,71E) point, placed in the country road that goes across Lakumulatu area. (Plan Nº 3)

2. PROJECT DATA

- The material execution Budget amounts TWO HUNDRED AND SIXTY-THREE THOUSAND SEVEN HUNDRED AND NINTY-ONE euros with FOURTY-TWO cents (263791,42 €), including IVA.
- Project execution time: 73 days (from September 7th to November 19th)
- Planning and workers number: Estimated at a maximum of 8 workers
- Author of the project: Asier Gamallo Valls
- Author of the Basic Safety and Health Report: Asier Gamallo Valls

3. CONSIDERATIONS FOR THE SAFETY AND HEALTH REPORT

3.1.OBJECT OF THE BASIC SAFETY AND HEALTH REPORT-

The objectives of this Basic Safety and Health Report are the following ones, whose order is indifferent when considering them all as part of the global set and of equal ranks:

1. To know the project and in collaboration with the managers of the work, define the most appropriate technology for the realization of the same, in order to know the risks that may result from it.

2. Analyze the project's work units based on their characteristics and emplacement, consistent with the technology and construction methods to be developed.

3. Define all detectable risks that may appear throughout the work.

4. Design the preventive lines according to a methodology that must be followed and their implementation during the construction process.

5. Communicate prevention methods among all the people involved in the work, involving them in order to achieve their best and most reasonable collaboration. This document is drafted mainly towards the construction company itself and its workers, and all workers involved at some point over there must be reached without any distinction, (own, subcontractors, freelancers...), in the parts of their interest and, to the extent, using of the mechanisms provided for that in the provisions in force.

6. Create a work health framework in which disease prevention is effective.

7. Determine the actions to be followed in the case in which our technical intention fails and the accident occurs, so that the assistance to the injured person is adequate and applied with the maximum velocity and attention possible.

8. Design the formation plan, to prevent by means of the correct working method, accidents.

9. To provide the prevention of risks from an economic point of view to each subcontracted company or of inter-employed people involved, in such a way to avoid practices contrary to Safety and Health.

This is how the Safety and Health Measures contemplated in the Safety and Health Report are adapted to the work systems. In any case certain extra units will be added to reach the desired job security levels for this work but fewer measures than those previously mentioned will never be considered.

4. SAFETY AND HEALTH PLAN OBLIGATIONS

The R.D. 1627/97 of October 24th ,in Art.7, establishes the obligation of the Main Contractor, to draft the mandatory Safety and Health Plan, which based on the existing Basic Safety and Health Report, analyses, studies, develops and takes into account the forecasts contained in the aforementioned report, in accordance with the work system and execution means to be used in the work.

This Basic Safety and Health Report has all the contents required in Article 6 of the aforementioned Royal Decree.

5. BASIC DATA

5.1. WORK DESCRIPTION

The project includes the construction of a country road which will offer a better service to the agricultural plots of the area.

The total length of the country road of this project, is 2254,5 meters and ascends all the Lakumulatu´s hillside from the Murillo el Fruto I country road to the agricultural estate nº18 in Ujué (Navarra).

The actions to be carried out on the roads will consist mainly of:

a) SETTING-OUT

The designed layout of the country roads must be plotted on the terrain in order to indicate on-site the main points of the axis and any other considered element.

b) CLEARING

The future occupancy area of the country road must be cleared from bushes and any other vegetation present in it.

c) TOPSOIL REMOVAL

The 30 first cm of the soil will be removed in order to avoid future stability problems of the country road.

d) EARTHWORKS

As the hillside over the designed country road is going to be settled is very hilly, earthworks operations will be needed in order to achieve the terrain height established in this project. For so 3/2 cut slopes and 2/1 fill slopes will be carried out unless in those points indicated in the project, where the fixed slopes has been changed in order to reduce the amount of earthwork. These operations will also be in charge of the formation of the platform where the subgrade will be placed.

e) DRAINAGE SYSTEM CONSTRUCTION AND ESTABLISHMENT

In order to ensure the correct water drainage not only of the country road, but also of the entire hillside, several drainage systems will be settled along the country road´s way. This drainage system will be made by gutters placed next to the cut segments and by transversal drainage structures.

f) BASE FORMATION

Once the aforementioned operations have been carried out, a base section made by construction and demolition waste (RCD) ballast will be settled over the subgrade as indicated in this project.

5.2.DESCRIPTION OF THE DESIGNED COUNTRY ROAD

The future country road will have the following characteristics:

a) GEOMETRIC DESCRIPTION

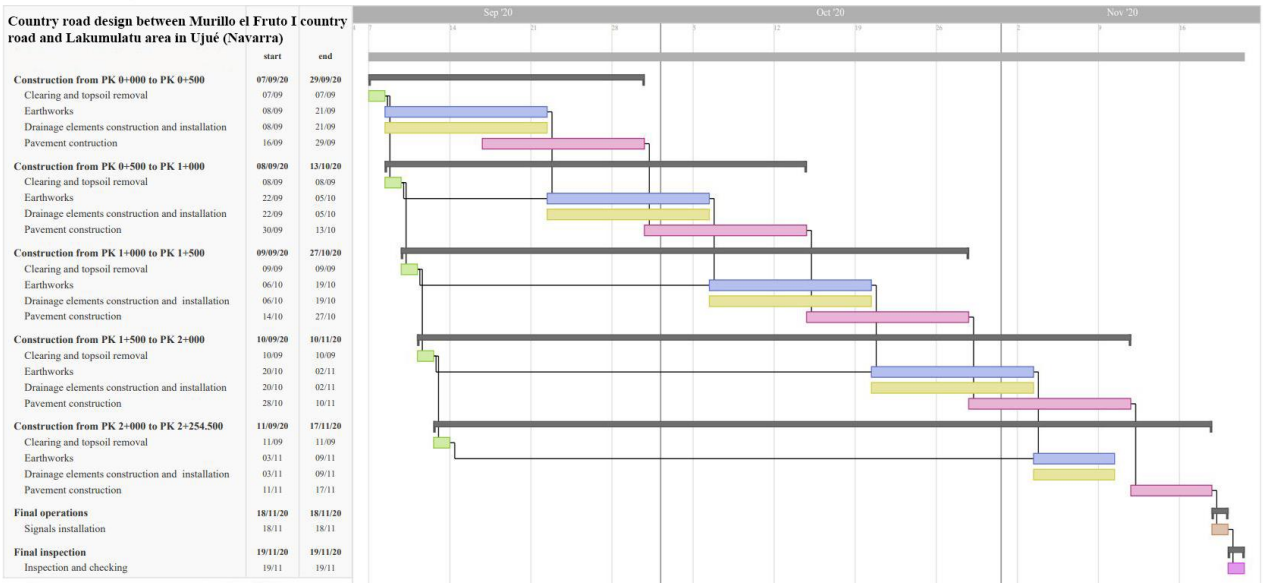
- Length: 2254,5 m
- Width: 4,0 m
- Pavement thickness: 0,70 m
- Traffic category: T4.22
- Traffic: Between 5 and 14 heavy vehicles/day

b) TECHNICAL DESCRIPTION

- Pavement: Uncoated pavement made by RCD ballast.
- Plot: Designed in this project and will be verified after the setting-out Grading: Adjusted to the terrain minimizing earthworks operations
- Transversal slope: 2%
- Compaction: 100% of Modified Proctor Test
- Factory works: According to Plans
- Water removal: Gutters and transverse drainage systems
- Subgrade: E1 (when adding the 30 cm of subbase)

5.3. EXECUTION OF THE WORKS

The work will be executed according to the following Gantt Chart (Figure 7):



Country road design between Murillo el Fruto I country road and Lakumulatu area in Ujué (Navarra)	start	end
Construction from PK 0+000 to PK 0+500	**07/09/20**	**29/09/20**
Clearing and topsoil removal	07/09	07/09
Earthworks	08/09	21/09
Drainage elements construction and installation	08/09	21/09
Pavement contruction	16/09	29/09
Construction from PK 0+500 to PK 1+000	**08/09/20**	**13/10/20**
Clearing and topsoil removal	08/09	08/09
Earthworks	22/09	05/10
Drainage elements construction and installation	22/09	05/10
Pavement construction	30/09	13/10
Construction from PK 1+000 to PK 1+500	**09/09/20**	**27/10/20**
Clearing and topsoil removal	09/09	09/09
Earthworks	06/10	19/10
Drainage elements construction and installation	06/10	19/10
Pavement construction	14/10	27/10
Construction from PK 1+500 to PK 2+000	**10/09/20**	**10/11/20**
Clearing and topsoil removal	10/09	10/09
Earthworks	20/10	02/11
Drainage elements construction and installation	20/10	02/11
Pavement construction	28/10	10/11
Construction from PK 2+000 to PK 2+254.500	**11/09/20**	**17/11/20**
Clearing and topsoil removal	11/09	11/09
Earthworks	03/11	09/11
Drainage elements construction and installation	03/11	09/11
Pavement construction	11/11	17/11
Final operations	**18/11/20**	**18/11/20**
Signals installation	18/11	18/11
Final inspection	**19/11/20**	**19/11/20**
Inspection and checking	19/11	19/11

Figure 7: Construction phase planning

5.4.ACCESSES AND CIRCULATION

Access to the work will be correctly signposted and identified. It is necessary to establish in the Work Centre a Safety and Health Signaling System in order to draw rapid and intelligible attention to objects and situations likely to cause specific hazards, as well as to indicate the placement of important devices from the safety point of view . They shall signal the works in accordance with the provisions of Royal Decree 485/1997, of April 14th, Signaling Safety and Health at Work and Rule 8.1 IC Vertical signaling.

In this work the signage will be necessary in:

a) ACCESS TO THE WORK

- Prohibition of entry to people outside the work
- Entry and exit for machinery

b) CIRCULATION INSIDE OF THE WORK

- Danger suspended loads
- Danger truck maneuvering
- Medicine cabinet placement
- Wellness and hygiene facilities placement
- Mandatory entry to work area

c) VERTICAL CIRCULATIONS

- Signal code - machinist
- Obligation to observe security measures

d) WORKPLACES

- Beaconing in slopes less than 2 m in height
- Beaconing or railing protection (depending on situation and risk) in slopes greater than 2 m in height
- Obligation to wear helmet
- Dimensioning of the work area

6. THIRD-PARTY INTERFERENCES

All access to the work site, as well as external vials will be marked by a signaling plan to be developed in the Safety and Health Report carried out by the Contractor. In any case, access to the work of people outside the work itself shall be prohibited by signals or posters Obviously, people outside the work will be prevented from passing through for the length of the different operations. At the end of the works on the country road, these materials will be removed.

It is necessary to establish in the Work Centre a Safety and Health Signaling System in order to draw rapid and intelligible attention to objects and situations likely to cause particular hazards, as well as to indicate the placement of important devices from the security point of view. They must signal the works in accordance with the provisions of Royal Decree 485/1997, of April 14th, Signaling Safety and Health at Work and Standard 8.1-IC Vertical Signage.

7. AFFECTED SERVICES

Before the beginning of the work, the different facilities companies must inform in writing for the location of their facilities in and around the premises, as well as the supply cut-off needs.

8. SIGNALING

The signals of the work will accompany the evolution of the work in the different risk phases.

9. ELECTRICITY SUPPLY

After consultation, and acceptance, with the electricity supplying company, the electricity will be taken from the general onslaught (if any), with the cable splice being carried out with the mandatory protections, from which the work installation will be assembled.

10.DRINKING WATER SUPPLY

Permission will be requested from the supplying company, for the onslaught and water channeling, in the most convenient way.

If possible, the hoses will take the same path as the electricity conduction on their way to the work, but will always go below it at the distances indicated in the R.E.B.T.

11.DIRTY WATER SPILLS

The dirty water from the work will be directly spilled into the existing sewerage network, currently connected to the public drainage network. If this is not possible, temporary sewerage and sewerage work must be undertaken.

12.CLIMATOLOGY

The climate is the present in the Navarra´s Zona Media, so, in principle, no special care must be taken from this point of view.

13.NEAREST HEALTHCARE CENTER

The nearest Healthcare Centers will be the following (Table 25):

Table 25: Nearest Healthcare centers

HEALTHCARE CENTER	TELEPHONE	ADRESS
Navarra´s Hospital Complex	848 42 22 22	Irunlarrea St. Nº3
Tafalla´s Medical Center	948 70 32 36	Sangüesa Avenue Nº19
Carcastillo´s Health Center	948 72 58 33	Pósito St. Nº6

In a work´s visible spot the route to the nearest Healthcare Centers will be placed, among which those corresponding to the of the Construction Company Mutua Work Accident will be indicated.

14. DATA OF INTEREST TO RISK PREVENTION DURING THE EXECUTION PHASE

14.1. WORK PHASES DESCRIPTION

a) PREVIOUS ACTIONS

- Setting out.

b) EARTHWORKS

- Mechanical clearing
- Cleaning and profiling of gutters
- Transverse drainage system construction
- Country road profiling

c) CIVIL WORK

- Reinforced concrete bell pipe
- Wingwalls
- Reinforced concrete wells

14.2. DESCRIPTION OF AUXILIARY MACHINERY AND MEDIA

a) Machinery

The main machinery to be used during the execution of the works in this work, are:

- Moto grader
- Backhoe
- Bulldozer
- Loader shovel
- Concrete mixer truck
- Dumper
- Tractor
- Dump truck
- Tank truck

- Vibrant roller
- Compressor and pneumatic hammer
- Concrete pumps on truck
- Crane on pen truck
- Sweeper

b) AUXILIARY MEDIA

The main auxiliary means to use are :

- Slings and chains
- Circulation signals
- Fences
- Generator groups
- Spotlights
- Manual tools and hand ladders
- Compressor
- Electrical concrete-mixer
- Vibrator
- Welder

15.HYGIENE AND HEALTH FACILITIES

15.1. WORK PERSONNEL ESTIMATION

The maximum number of people in the work site is estimated at 8 operators.

15.2. WATER SUPPLY

The company will provide its staff, in the workplace, with drinking water.

15.3. LOCKER ROOMS

The company will have in the workplace locker rooms for the use of the staff.

The surface of the changing rooms will be 2 m² for each worker and will have a minimum height of 2,3 m.

They will have metal or wooden seats and cabinets so that workers can change their clothes and leave their personal effects; they will be provided with a key, one of which will be handed over to the worker and another will stay in the office for emergencies.

Minimum endowment:

- Locker room: 60 m² of useful surface
- Number of lockers: 1 unit/worker = 30 lockers units

15.4. TOILETS

The toilets will be attached to the locker rooms. The floors, walls and ceilings of these units must be smooth and waterproof and with materials that allow washing with disinfectant or antiseptic liquids as often as necessary.

Minimum endowment:

- Toilets Surface: 60 m² of useful surface

These toilets will have the following characteristics:

a) WASHBASINS

The number of washbasins will be at least one for every ten users. The company will provide them with individual towels or hot air dryers, automatic towel racks or paper towels, with containers.

- Number of washbasins: 1 unit /10 workers = 3 units

b) TOILET SEATS

The number of toilet seats will be one for every 25 users. They will be fully equipped and sufficiently ventilated. The minimum cabin dimensions shall be 1,00 x 1,20 and 2,30 m in height. There will be 1 hanger per cabin.

- Toilet seats number: 1 unit/25 workers = 2 units .
- Urinary number: 1 pc/25 workers = 2 units

c) SHOWERS

The number of showers will be 1 shower for every 10 workers and will be hot and cold water. There will be one hanger per cabin.

- Shower number: 1 unit/10 workers = 3 units

15.5. DINING ROOM

The company will have a dining center for use of their workers.

The dining room shall be equipped with benches, chairs and tables; it will be kept in perfect condition and will have the right means to heat meals, including sinks with hot water, garbage bin with lid, etc.
The area of this facility will be 2 m^2 per worker and shall have a minimum height of 2,3 m.

Minimum endowment:

- Dining room: 60 m^2 useful surface
- Table number: 1 unit /10 workers = 3 tables
- Banks: 1 unit/5 workers = 6 banks
- Heat meals: 2 units
- Trash Containers: 2 units

16.FIRST-AID KIT

A medicine cabinet with the necessary means to carry out emergency cures in the case of an accident will be available in the workplace and will be provided by a person trained and appointed by the company.

17.PREVENTIVE PLANIFICATION IN THE CONSTRUCTION PROCESS

17.1. EXPECTED PRODUCTION PROCESS

a) NUMBER OF WORKERS

The maximum number expected in the work is equal to 8 operators.

b) WORK PHASES

The work phases that will take place in the execution of this project are those referred in the point number 6 of this document.

18.PREVENTIVE ANALYSIS ACCORDING TO THE WORK PHASES

In view of the methodology of the work process, the number of workers and the critical phases in prevention, the detectable risks are considered to be of the following types:

- The ones made by the laborer's malpractice
- The ones made the operation carried out by one or more workers
- The ones derived from formal factors and workplace location
- The ones which are provoked by the used media

This report opts for the methodology of identifying at each stage of the work process the specific risks, work equipment, collective protections, individual protective equipment, prevention and protection measures to be taken, as well as the Preventive Standards to be observed at each stage of work.

This methodology does not imply that, in each phase, there are only these risks or that these security measures should be applied exclusively.

The same can be said for the auxiliary means to be used, or for machinery, whose Use Standards are included in this Basic Safety and Health Report.

Each Contractor shall be given the affecting part of this report, as well as the different Use Standards of the work equipment and auxiliary means, defined in each construction unit, included in it.

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Descriptive Report

-BASIC SAFETY AND HEALTH REPORT -

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. SAFETY PROCEDURES AND STANDARDS

The procedures described below are aimed at serving as working instructions to be applied during the implementation of the various activities that include the implementation of this project.

These procedures, as well as the Work Teams and Auxiliary Means charts that are contemplated in this Report and that affect to each work unit or activity, must be provided to the Contractors affected by the work execution, as a previous information to the execution of them and as a work instruction, complementary to the implementation, and that will be mandatory for the performance of these.

It must also be considered that these documents will not be closed, they must be kept alive during the course of the work, so they must be reviewed before the execution of each of the works and updated, in the case of modifications in the process of execution or in the case of using new means, in advance of their implementation in the work.

1.1.PREVIOUS WORKS

a) SETTING-OUT

PERFORMANCE DESCRIPTION:

This activity that takes place from the beginning of the work until its end, includes all the tasks, that a specialized surveying team, formed generally by a surveyor and two pawns, performs to leave milestones and measures referenced in the land, defining through the setting-out, all geometric data, to be able to carry out the activities and execute the construction elements that make up the work.

This team begins its work before the beginning of the work activities, performing the previous setting-out and other checks to define the previous phases of the work.

The equipment normally travels with a van or off-road vehicle, which has the capacity to carry the devices, tripods, sights and auxiliary means for the setting-out execution.

Their exposure to Risk of Accidents is high, as they travel and have a presence in all the excavations and activities of the work, throughout the site and throughout its duration. However, the need to place measuring devices in stable locations means that the operator's risks are reduced by being normally removed far from the work.

The pawns, who by their approach to the cuts and their situation in them, have a higher degree of accidents.

The particular setting-out operations of the different work units begin with the clearing, the leveling work, earthworks, works of transversal and longitudinal drainage, pavement construction, etc.

The duration of this work phase is the same as the work duration.

The number of workers exposed to risk is usually one surveyor and two pawns for each team.

SAFETY STANDARDS DURING THE SETTING-OUT PROCESS:

- All team must wear non-slip and special boots to avoid drops on the slopes and at the same level.
- Climbs or positions in very hilly areas should be avoided if the operator is not properly tied to a rope, with a fastening belt and a fixed point at the top of the area. For testing or materializing data in formwork areas or at heights of structures and factory works, it will have to be accessed by regulatory stairs or adequate accesses, such as tubular structures (fixed stairs).
- All work carried out in heights (checking or setting out operations) must be carried out, with fastening belt and anchored to structure´s fixed points if there are not any collective protections.
- For road checks or setting-out operations, they shall be carried out with the corresponding equipment and signage of working personnel.
- Stays during setting-out operations should be avoided in areas where objects may fall, so work teams will be notified to avoid actions that may result in objects or tools projection while working in that area.
- To nail the stakes with the help of long pointers workers will have to wear gloves, and pointers with hand bump protector.
- Pointers with deformations in the strike zone should be avoided due to the risk of steel particles projection into face and eyes. Anti-particle glasses will be worn during these operations.
- In sections where the machinery is in motion and in areas where materials are provided by trucks, the setting-out team and equipment stay will be avoided, adopting a safety distance that will be fixed according to the foreseeable risks.
- The existence of electrical wires shall be checked before setting-out activities to avoid direct contact with them.
- Setting-out operations in traffic areas will be carried out with reflective vests and supported by signals.
- In areas where there are power lines the used sights will be dielectric.
- The vehicle used for the team and equipment transport shall be checked on a regular basis and must be driven by the same operator.

1.2.EARTHWORKS

a) CLEANING AND PROFILING

MACHINERY:

- Moto grader
- Backhoe
- Bulldozer
- Loader shovel
- Truck with swing box
- Dumper

AUXILIARY MEDIA:

- Eelectrical and metal underground detector
- Safety signals, fences and warning and risk indication beacons
- Warning signs to third parties

MATERIALS:

- Vegetation
- Vegetable mantle
- Surface layer of stone materials

MOST FREQUENT RISKS:

- Falls at the same level
- Falling objects
- Shocks or hits against objects
- Machinery rolling
- Unforeseen transported materials drop
- Fortuitous vehicles start-up
- Trappings
- Hits by moving machinery
- Crushing
- Breakage of parts or mechanisms with particle projection
- "Whip Strike" by cable breakage
- Burns in vehicle maintenance operations
- Dusty environment
- Noise pollution
- Indirect electrical contact
- Backache for over-effort and exposure to vibrations

- Osteoarticular injuries from exposure to vibrations
- Injuries in hands or feet
- Strange bodies in eyes
- Fire
- Animals and/or parasites.

PERSONAL PROTECTION:

- Safety helmet
- Gloves against mechanical hazards
- Lumbar protection anti-vibration belt
- Class A anti-noise protectors
- Class II safety boots with non-slip flooring
- Water boots
- Water suit

COLLECTIVE PROTECTION:

- Interior and exterior construction signals
- Pedestrian containment fences (gutters or deep wells)
- Reflective strips (ditches, wells, slopes)
- Advertising posters: landslides, forbidden passage, circulate on the right, etc.

RULES OF ACTION:

- During mechanical clearing, areas where rocks or trees landslide may occur over people, machinery or vehicles, shall be appropriately marked and signposted. Posts or unstable elements should be properly supported with braces and javelins.
- The interior installations will be cancelled and disconnected, except those necessary to carry out the work and protections.
- Where there is interference between clearing work and the traffic areas of pedestrians, machines or vehicles, they shall be managed and monitored by appropriately trained auxiliary personnel, monitoring and directing their movements.
- A parking area for vehicles and machines, as well as a storage and collection of inflated materials and fuels (petrol, diesel, oils, greases, etc.), shall be established in a safe place outside the area of influence of the work.
- If necessary, the plants, shrubs, trees to be taken into account for conservation, protection, transfer and/or subsequent maintenance will be selected.
- In winter establish a temporary lighting system of the areas of passage and work, having sand and fat salt on the frost-free puddles.
- In summer, pre-watering of work areas that may cause dust during their removal must be carried out.

b) OPEN-AIR EXCAVATION

MACHINERY:

- Tractor
- Loader shovel
- Dumper
- Dump truck
- Scrapers
- Backhoe
- Moto grader
- Tanker truck

AUXILIARY MEDIA:

- Slings
- Metal shed
- Circulation signals
- Fences
- Spotlights
- Hand ladders

MATERIALS:

- Soil
- Rocks
- Mix of land and rock

MOST FREQUENT RISKS:

- Abuses
- Collisions
- Overturns
- Crushing: landslide
- Drops at the same or different level
- Material drops
- Hits with moving parts of machines
- Electrocutions

PERSONAL PROTECTION:

- Reinforced toe boots and rubber floor
- Boots of non-slip rubber (operators)

- Reinforced rubber toe boots (cut, rain)
- Anti-vibration belt
- Ear protector
- Dust mask (optional)
- Dust goggles (optional)
- Waterproof suit (rain)
- Reflective clothing (night work)

COLLECTIVE PROTECTION:

- Interior work signaling
- Outdoor construction signaling
- Pedestrian containment fences (ditches or deep wells)
- Reflective strips (ditches, wells, slopes)
- Advertising posters: landslides, forbidden passage, circulate on the right, etc.
- Shoring
- Railings and fearless

RULES OF ACTION:

- Access to the work shall be prohibited from any person oblivious to the work.
- Work accesses will be free of obstacles. If the access is made through a slope, it will be peeled and will present a railing handrail at 0,90 m.
- Machines and vehicles will park outside the work area to avoid collisions.
- The possible vehicle and machine circuits shall be signaled to prevent outrage.
- In dust production area, it shall be watered to avoid it, whenever possible, in advance.
- When visibility is low (fog, rain), vehicles will circulate with the given dipped-beam headlights.
- The speed limitations will depend on the work conditions: accesses, number of people working, visibility, etc.
- It is strictly forbidden, to stay within the radius of action of the machines.
- Slopes will be healed and unstable areas will be conveniently marked.
- The assistant in unloading operations shall be sufficiently far, removed from the vehicle or machine. It shall indicate by means of a pull or similar system, the place where the discharge should occur.
- In an abnormal situation (rain, fog, etc.), precautions will be increased.
- The reverse of the vehicles with acoustic signals shall be accompanied, being directed by an operator who will be located on the left side of the vehicle, in case of concentration of people.
- The adhesion of the terrain in an area of large cross slopes shall be checked.
- All machinery must comply with the specifications set out in the book "Safety Systems Incorporated in Machinery".

- After tilting, the vehicle case must be completely low before continuing working.
- It is strictly forbidden to transport people in vehicles and machines, except in those with a passenger seat.
- Whatever handling to be carried out on machinery or construction vehicle, it will be done with it stopped and by placing or blocking moving parts that could be put into operation unexpectedly.
- It shall be avoided to be placed under suspended loads.
- Gutters, trenches and wells will be marked to prevent falls at different levels.
- Transfers of heavy machinery, which have to go out to roads, shall be preceded by a driver's car with indicators, without exceeding the maximum authorized speeds.
- Materials should not be collected in areas near the edge of the trench.
- In trenches and wells, the excavation products will be collected in such a way that the load responsible, is at a distance equal to the depth of the same plus 1 meter.
- Machinery and vehicles shall be avoided as far as possible in the vicinity of the excavation edges to avoid overloads and vibration effects.
- Discharges of dumpsters in embankments and landfills shall be carried out in stable, and horizontal places if possible, not getting too close to the slope. It will be extended/matched with a tractor or any other similar mean.
- Problems of landslides or landslides in ditches and wells are solved by shoring or making some small embankments in the edges.
- Fills´ slopes should be monitored changes occur and due to overload effects.
- For guidance, a table with stable slopes according to type of terrain will be attached:
- It is very convenient to leave berms of 50-80 cm on slopes of height greater than 1,50 meters.
- Access to ditches and deep wells will be made via metal stairs.
- When for construction needs, the shoring solution is adopted to avoid landslides, it should be carried out with great care and supervised by a responsible person.
- The unshoring operation is generally as dangerous as the shoring operation, so a prior study of the process to be followed should be carried out, both in one case and in the other.
- The characteristics of the terrain are altered by the weather conditions, so the excavations will be subjected to special surveillance, after rains, ice snow and especially in thaws.
- Water is a great enemy of slope stability in excavations, so they must be removed, either by bilge, by pumping or diverting the current. Whenever this circumstance is produced, such excavation shall be subjected to special surveillance.
- Vibrations caused by blasting can affect the stability of excavation slopes.
- Safety distances to power lines are (Table 26):

Table 26: Safety distances to power lines depending on its voltage

Up to 66,000 volts	3m
Higher than 66,000 volts	5m

- In night works, lighting shall be enough in all parts of the work, in accordance with the following classification (Table 27):

Table 27: Night lighting requirements depending on the working area

Passage places	20 lux
Work zones	100 lux
Electrical charts	200 lux

c) COUNTRY ROAD PROFILE (FILLING AND COMPACTION)

MACHINERY:

- Tractor
- Loader shovel
- Dumper
- Dump truck
- Moto grader
- Tanker truck
- Vibrant roller

AUXILIARY MEDIA:

- Slings
- Circulation signals
- Metal house or caravan
- Fences

MATERIALS:

- Soils

MOST FREQUENT RISKS:

- Abuses
- Hits or imprisoning with moving parts of machines
- Drops at the same or different level
- Collisions and overturn
- Dusty environment

PERSONAL PROTECTION:

- Rubber boots with reinforced toe (cut with rain)
- Reflective clothes

- Anti-vibration belt
- Helmet with bearded
- Working coveralls
- Ear protector
- Dust mask and goggles
- Waterproof suit
- Non-slip rubber floor boots (operators)

COLLECTIVE PROTECTION:

- Interior work signals
- Outdoor construction signals
- Fences for pedestrian protection
- Railings and fearless
- Acoustic and luminous reversing device in vehicles

RULES OF ACTION:

- Any person oblivious to the work shall be prohibited from accessing the work.
- Machines and vehicles will park outside the work area to avoid collisions.
- Vehicle and machine circuits that are necessary to avoid hit-and-run shall be marked.
- In dust production areas, it shall be watered to avoid it, whenever possible, in advance.
- When visibility is low (fog, rain), vehicles will circulate with the given dipped-beam headlights.
- Speed limitations, will depend on the work conditions: accesses, number of people working, visibility, etc.
- It is totally forbidden, stay within the radius of action of the machines.
- The assistant in unloading operations shall be sufficiently far removed from the vehicle or machine. It shall indicate by means of a pull or similar system, the place where the discharge should occur.
- In an abnormal situation (rain, fog, etc.), precautions will be exercised.
- All machinery must comply with the specifications set out in the book "Safety Systems Built into Machinery".
- Whatever handling to be carried out on machinery or construction vehicle, it will be done stopped, and by placing or blocking moving parts that could be put into operation unexpectedly.
- Transfers of heavy machinery, which have to go out to roads, shall be preceded by a driver's car with indicators, without exceeding the maximum authorized speeds.
- The reverse of the vehicles with acoustic signals shall be accompanied, being directed by an operator, which will be located on the left side of the vehicle, in case of concentration of people.
- It is strictly forbidden to transport people in vehicles, except in those with a passenger seat.
- After tilting, the vehicle case must be fully lowered before continuing.

- Vehicle circulation in the vicinity of the edges of the excavation shall be avoided when possible to avoid overloads and vibration effects.
- Safety distances to power lines are (Table 28):

Table 28: Safety distances to power lines depending on its voltage

Up to 66,000 volts	3m
Higher than 66,000 volts	5m

- In night works, lighting shall be sufficient in all parts of the cut, in accordance with the following classification (Table 29):

Table 29: Night lighting requirements depending on the working area

Passage places	20 lux
Work zones	100 lux
Electrical charts	200 lux

1.3.PAVEMENT

a) BASE AND SUBBASE CONSTRUCTION

MACHINERY:

- Steamroller
- Vibrant tray
- Agglomerate paver
- Tire compactor
- Self-propelled rollers
- Trucks
- Tank trucks
- Tractor
- Sweeper
- Compressor

AUXILIARY MEDIA:

- Tools
- Radiotelephones
- Circulation signals
- Traffic lights
- Fences, lights, beacons, etc.
- Standard electrical frames with differential switch and grounding

MATERIALS:

.

- Aggregates
- Soil

MOST COMMON RISKS:

- Collisions and traffic over traffic of vehicles and machines.
- Overturns
- Drops at the same or different level
- Imprisoning and striking with moving parts of machinery
- Injuries from over efforts
- Falling objects
- Shard and spatter impacts
- Electrocutions
- Explosions (boiler, conductors, etc.)

PERSONAL PROTECTION:

- Helmet
- Working overalls
- Leather boots with reinforced toe
- Anti-vibration belt
- Protective glasses
- Gloves

COLLECTIVE PROTECTION:

- Outdoor circulation signaling
- Signage of interior work
- Fences
- Reflective tapes
- Lights and beacons
- Fire equipment

RULES OF ACTION:

- Vehicles and machines shall be operated only by assigned operators.
- Vehicles and machines shall be checked periodically with special attention to the breaking and steering systems, acoustic signals and lighting.
- It is forbidden to have people in machines or vehicles that do not have a seat for companion.
- Signals of the work area and if safety requires it, employment of people for the management of maneuvers.

- Provision of the necessary measures to prevent vehicles and machines from being accidentally moved.
- Work in areas with the existence of power lines, telecommunications, etc., shall keep the rules of accompanying regulatory distances.
- The machines will work on the tasks for which they were conceived.
- If the machinery and vehicles are damaged in places of transit, they shall be conveniently indicated.

1.4.DRAINS

a) CONCRETE STRUCTURES

MACHINERY:

- Concrete mixer truck
- Concrete pumps on truck
- Concrete mixer

AUXILIARY MEDIA:

- Tools
- Welder
- Vibrators
- Circulation signals
- Traffic lights
- Fences, lights, beacons, etc.

MOST COMMON RISKS:

- Collisions and traffic over traffic of vehicles and machines
- Overturns
- Drops at the same or different level
- Imprisoning and striking with moving parts of machinery
- Injuries from over efforts
- Falling objects
- Burns
- Concrete dumping over an operator

RULES OF ACTION:

- Strong end-of-travel stops of concrete trucks will be installed to avoid overturning.
- It is forbidden to approach the wheels of concrete trucks less than 2m. (as a general rule).

- It is prohibited to place operators behind concrete trucks during reverse movements.
- Solid railings will be installed in cuts protecting the gutter guide cut.
- A safety cable tied to "solid points" shall be installed, in which to attach the seat belt carabiner to the cuts at risk of falling from height.
- Safe "emergency points" will be enabled; in those situations of half-hillside discharge.
- The pouring maneuvers shall be led by a foreman who will monitor no unsafe operations.
- To avoid possible accidents, the following rules should be observed during the execution of the work:
    - The capacity of the tank shall be in accordance with the maximum permissible load of the crane.
    - The standards to be governed by the assembly, placement and use of the crane shall take into account the standards given in this manual.
    - The opening of the pouring bucket will be executed exclusively by activating the lever with the hands protecting them with waterproof gloves.
    - From the bucket some guide ends will rise to facilitate the positioning for its pouring. It is forbidden to guide it directly in order to prevent falls by pendular movement of the cube.
- When the welder is going to be used to fix the reinforcements, the operator must wear the clothes and must comply with the specifications indicated in the point related with that tool.

PERSONAL PROTECTIONS:

- Helmet
- Safety boots
- Rubber boots and rainy weather suit
- Anti-projection glasses
- Seat belt

b) TRANSVERSAL DRAINAGE PIPES SETTLEMENT

MACHINERY:

- Truck
- Crane on pen truck
- Backhoe

AUXILIARY MEDIA:

- Tools
- Slings and chains
- Circulation signals
- Traffic lights
- Fences, lights, beacons, etc.

MOST COMMON RISKS:

- Collisions and traffic over traffic of vehicles and machines
- Overturn
- Drops at the same or different level
- Imprisoning and striking with moving objects or moving parts of machinery
- Injuries from over efforts
- Falling objects
- Chain/sling break

RULES OF ACTION DURING TRANSVERSAL DRAINAGE PIPES SETTLEMENT:

- The trenches will be correctly signaled during the day and during the night
- It is forbidden to approach the wheels of the crane/pen truck to a distance closer than 2m. (as a general rule).
- It is prohibited to place operators below the pipes when they are moving into the trench.
- Solid railings will be installed in cuts protecting the gutter guide cut.
- The pipe will not be raised by the crane until it has been checked that it is well tied.
- Safe "emergency exits and points" will be disposed along the trench.
- When the pipe is lowered into the trench, special care will be taken with the workers in it
- To avoid possible accidents, when the pipes are going to be placed in the trench, operators should be careful with possible crushing or slipping parts.

PERSONAL PROTECTIONS:

- Helmet
- Harness.
- Rubber boots and rainy weather suit
- Working globes.
- Seat belt

2. ACTION RULES WITH AFFECTED SERVICES.

Some working rules relating to these installations are attached below.

All the safety regulations, detailed below, will be subjected to the general and specific instructions provided in writing by the company that owns the interfered services and only in the event that in any section, if any security requirements were lower than those indicated here in, these would prevail.

In any case, the actions to be carried out to execute the diversions or routes of the affected services, will be carried out with the blessing of the affected companies.

2.1. WORKS IN PROXIMITY TO AIR POWER LINES. APPLICATION FIELD

PREVIOUS PERFORMANCES:

- Identification of the company of the following characteristics of the line in the work area:
  - Voltage.
  - Supports height.
  - Minimum distance between conductors and the ground.
- In the event that the most unfavorable distances between the power line and the work area or machinery and vehicles that pass below them, is 5 meters, both vertically and horizontally, some arrangements will be made to obtain the corresponding unloading or diversion of the line.
- In the event that the unloading or diversion of the line is not possible, or there are reasonable doubts about the power cut made by the company (start and end undefinition of the discharge, absence of documentary justification on the manner of the discharge, etc.), the following procedures shall be considered for all purposes in which the line remains in tension, so that, it must be worked on the affected area by the line, the following procedures should be considered:

OPERATION PROCEDURES:

- Isolate naked drivers: isolation is only possible for voltages up to 1,000 volts. Placement and removal of insulation must be done by the line owner.
- Limit the translation, rotation and lifting movement of land by mechanical stop devices.
- Limit the work area, lifting machines or earthmoving machines, by protection barriers.
- If, in particular cases, none of the measures mentioned is applicable, provide the ingenuity with insulated protective baskets. The dielectric shape and rigidity of the support insulators should, in any case, discussed with the owner of the line.

PROTECTIVE BARRIERS:

- The protective barriers are constructions usually formed by hangers placed vertically and whose foot is firmly fixed on the ground, and shutters, joined by lengths or boards.
- The size of the elements of the protective barriers must be determined according to the strength of the winds blowing in the region.
- The maximum vertical space between the lengths or boards should not exceed 1 meter.

- In place and placement of lengths or boards, retaining cables with signaling cartons can be used. The wires must be tight. The vertical space between the retaining cables must not exceed 50 cm.
- Between lengths, boards or cables, nets shall be placed whose meshes opening does not exceed 6 cm to prevent metallic elements from scaffolds, machines, etc. to enter into the danger zone.
- Protective barriers, protective rings, retaining cables and metal nets must be grounded in accordance with the requirements.
- If the protective barriers are for the machinery or vehicles passage, barriers should carry with them protection on either side of the airline.
- The maximum passage height must be indicated by appropriate panels fixed to the poles. The step entries must be pointed out on both sides.

RECOMMENDATIONS TO BE OBSERVED IN CASE OF ACCIDENT:

a) Line drop:

- Staff should be prohibited from accessing into the danger zone until a specialist proves that it does not have any tension. Only in the event in which there was a crash and they were sure that there is a low voltage in the line, an attempt be made to separate it from the line by non-conductive elements, without touching it directly.

b) Contact the line with machines:

If any machine or its load comes into contact with a power line, the following measures must be taken:

- Keep calm and stay in your command plan trying to remove the machine from the line, placing it out of the area. The driver must warn the closest staff to stay away from it.
- In the event in which it is not possible to separate the machine from the power line the driver must leave it by jumping with both feet together at a distance as far away from it as possible.

2.2.WORKS IN PROXIMITY TO UNDERGROUND POWER LINES

PREVIOUS PERFORMANCES:

- Be informed of the possible existence of buried cables, preferably in the power company that
- supply power to the area.
- Make the appropriate arrangements to get the corresponding disclaimer of the line.

- In the event that the disclaimer is not possible, or there are reasonable doubts about the power cut made by the company, it shall be considered for all purposes that the line remains in tension, so that, in case it must inevitably work in the area affected by the line, two procedures shall be considered:

1º.- The characteristics of the line are known (tension, depth, layout and protection system).

- Mechanical excavation can be done to a distance (vertical and horizontal projections) of 0,5 m, and the approach must be continued manually until access to the protection (factory of brick, tube, etc.) or to the insulating cover in case of covering with sands or earths.
- The working procedure from the excavation beginning, through the corresponding apes, change of site (if applicable) and subsequent protection, will be carried out in accordance with the supplying company of electric fluid.
- These work from its beginning to its end must be supervised "on-site" by a person responsible of them.
- Compulsory personal protections, risk-specific, shall consist of dielectric gloves suitable for the line tension, protected with leather work gloves. Helmet with beard, eye protection and class III safety footwear (insulator) will also be mandatory.
- The work responsibility will not allow the start of it until it does not verify that the working procedure has the accordance of the electric company and that the staff uses the mandatory personal protections.
- In any case it is mandatory to carry out excavations, at least two points of the plot, to confirm the accuracy of the plot, before the start of the work.

2º.- The existence of the line is known but not its characteristics

- To ask the company to define the coordinates of the line layout in the area to be operated by means of a field detector.
- If the electric company offers assurances as to the accuracy of the measurements operate in accordance with paragraph 1; but requesting supervision by qualified person belonging to the power company.
- If the measurement does not guarantee what is required, or is not carried out by the electricity company, make the corresponding written to the work property putting it in background, as well as the non-start of work in the possible affected area, given its extreme danger, in order to carry out the necessary steps for the corresponding discharge, or, when appropriate, the realization of the work by the electric company or otherwise, with the corresponding specialization in tension work.

The Work Director shall consider this applicable security procedure with the same thoroughness to both own personnel and subcontractors.

2.3.WORK IN WELLS OR SANITATION NETWORKS

For the completion of the work in which it is mandatory to enter in wells, collectors, etc., the following measures must be considered:

- The ventilation is enough, so that the oxygen percentage in the air does not drop below 18%, that the hydrogen sulphite content is below 100 p.p.m. and that there is no methane gas in sufficient proportion to initiate a fire or explosion. To this end, the concentration of these components shall be continuously measured.
- In case of rain or anticipation of it, work will be suspended.
- There will always be a person outside checking the work, to act quickly in case of emergency.

2.4.WORKS IN PROXIMITY TO GAS AND/OR FLAMMABLE LIQUIDS

PREVIOUS PERFORMANCES:

In case of buried pipes, the following steps will be followed:

a) Identification:

- The path of the pipe to be excavated from the construction Plans of the pipe will be identified.

b) Signaling:

- The pipe will be located using a detector, marking and signaling its direction and depth with signals.

OPERATING PROCEDURES:

a) Buried conductions at a depth equal or less than 1 meter:

- In this case the work will always start by doing checks by hand, until reaching the pipe top generating. As many checks as deemed necessary to ensure the position of the pipe will be done.

b) Conductions buried at depth greater than 1 meter.

- The excavation with machine can be started until reaching 1 meter over the pipe, proceeding as in the previous point.

Once the pipe is located, up to 0,5 meters from the pipe can be excavated by mechanical means.

SAFETY STANDARDS:

When working on the proximity of flammable liquids and gases pipes, the following points shall be considered:

- Periodic verification of the existence of gas in the environment. In the event of gas or fire leakage, all construction personnel shall withdraw beyond the designated safety limit, receiving instructions only from the competent staff of the company that owns the facility.
- The working area, must be checked and correctly signposted, being completely forbidden to smoke or make any type of fire within the affected area, for which the use of combustion machines will be considered.
- Compressors and any type of electrical machines (generator set, etc.) shall be placed, whenever possible, outside the area.
- All lights, fences and surveillance will be provided and maintained for the protection of the works or for third-party security when the case requires it.

3. AUXILIARY ELECTRICAL INSTALLATION

ACTIONS DESCRIPTION:

This section provides the forecasts and standards to be considered, in order to assemble and maintain in good conditions of use the auxiliary electrical installation of the work site.

RISK IDENTIFICATION:

During execution, installation and maintenance:

- Objects and/or tools in electrical appliance mounting operations
- Direct electrical contacts: during installation /commissioning and in conservation and maintenance operations
- Indirect electrical contacts
- Indirectly produced by electricity (height drops, shocks, etc.)

During use:

- Direct electrical contacts with unprotected active parts, stripped wires, etc.
- Indirect electrical contacts for poor receiver status, masses accidentally put into tension (frames, groups, metal objects)
- Indirectly produced by electricity

- Stumbles and falls at the same level provoked by poorly conductors plotting and frames and generator sets in dangerous locations

GENERATORS:

Where the power supply is a generator set, not only the same considerations as fixed installations shall be taken into consideration, but also the following particular considerations must be taken into account:

- Groups purchased or rented must be CE marked (Declaration of Conformity of the manufacturer with safety regulations on machines and equipment)
- As far as the protection against indirect contacts (grounding) of receivers is concerned, equipment and masses shall also cover the masses of the group itself and its auxiliary equipment.
- The Protective Mount to be used will be the MP-1 (NTP-142). Dangerous tensions in the masses must be protected with differentials in action combined with grounding.
- It will have a thermal device that will stop the group in prudential time against intensity return heating in possible defects.
- It will have high-sensitivity differential switches for all outlets (group or framed).
- The installation extension will be limited as far as possible.
- At each displacement or change of placement of the group, the pike will be nailed to the grounding as much as possible.

4. AUXILIARY FIRE INSTALLATION.

INTRODUCTION:

The causes that lead to the appearance of fire in a work are no different from those that generate it elsewhere: the existence of a source of ignition (bonfires, braziers, solar energy, welding work, electrical connections, cigarettes, etc.) together to a combustible substance (wood formwork, machinery fuels, paints and varnishes, etc.) since oxygen is present in all cases.

ACTION PROVISIONAL MEANS:

Like temporary construction facilities, they are temporary in nature, using them to carry out the commitment to make a certain construction, the provisional means of prevention are the material elements that the construction staff will use to attack the fire.

According to UNE 230/0, and according to combustible nature, fires are classified into the following classes:

- Class A:
    - Also called dry. Combustible material are flammable solid materials such as wood, paper, straw, etc. with the exception of metals.
    - The extinction of these fires is achieved by the refreshing effect of water or solutions containing a large percentage of water.

- Class B:
    - They are fires of flammable liquids and fuels, solid or liquefiable.
    - The most common combustible material is tar, gasoline, asphalt, solvents, resins, paints, varnishes, etc. The extinction of these fires is achieved by the insulation of the fuel from the ambient air, or by suffocation.

- Class C**:**
    - They are fires of substances that under normal conditions pass into the gaseous state, such as methane, butane, acetylene, hydrogen, propane, natural gas.
    - Its extinction is achieved by suppressing the gas arrival.

- Class D:
    - They are those in which flammable metals and reactive chemical compounds such as magnesium, powdered aluminum, titanium, potassium, sodium, lithium, etc. are consumed.
    - Special fire extinguishers must be used to control and extinguish fires of this type; in general, no fire extinguishing agent used to combat Class A, B or C fires is used, as there is a danger of increasing the fire intensity due to a chemical reaction between one of the extinguishing agents and the metal being burned.

In general, and once the fire classes have been described, it can be said that in or near electrical equipment, it is necessary to use non-conductive extinguishing agents (such as carbon dioxide, halon or multipurpose powder), or in other words, they can not contain water in its composition.

In this case, the most likely fire that can be provoked are Class A, B, and C.

For this purpose, fire extinguishing agents suitable each of the phases of fire must be available on site.

Therefore, a periodic review and check of the provisional electrical installation as well as the correct storing of flammable substances will be carried out during the execution of the work.

EXTINCTION MEDIA:

- The extinguishing media shall be as follows: portable extinguishers, installing two of 5 Kg carbon dioxide for each collection of flammable liquids and paints; one of 6 kg of multipurpose dry powder in the construction office; two of 5 kg of carbon dioxide next to

the general protection box and, finally, two units of 6 kg of multipurpose dry powder in the tool stores, etc.

- In addition, they will be distributed in the transit areas in order to have a quick response to the fires in any position of the work.

MANUALLY OPERATED EXTINGUISHERS:

- They will have inside a load, which driven by pressure, allows to quell incipient fires. They must bring a built-in support for fixing to vertical walls.
- It shall be indicated on a board: type and capacity of load, service life and discharge time.
- It will be approved by the Industry Ministry (Table 30).

Table 30: Extinguisher classification

TYPES OF FIRE EXTINGUISHERS		Fire Class A	Fire Class B	Fire Class C	Fire Class D
Polyvalent water	AP	3	1		
From jet water	AP	2			
Physical foam	EQ	2	2		
Conventional Powder	PS		3	2	
Multipurpose Powder	PY	2	2	2	
Special Dust	PE				1
Carbon dioxide	AC	1	2		
	SUITABLE CLASSIFICATION:				
1		Very suitable			
2		Suitable			
3		Acceptable			
	FIRE CLASSES				
A		Fire of solid materials. Generally, of an organic nature.			
B		Fire of liquids or liquefiable solids			
C		Gas fire			
D		Metal fire			

OTHER MEANS OF EXTINCTION:

Other means that can be used in fire extinction are water, sand and other commonly used tools (blades, rakes, spikes, etc.).

UTILIZATION:

- As already mentioned above, the choice of extinguishing agent should be made according to the most likely fire classes
- The location of the fire extinguishers shall be chosen in the vicinity of the places where a fire can be given. The extinguishers shall in any case be appropriately approved and revised
- All these measures have been considered for the personnel to extinguish the fire in the initial phase, if possible, or diminish their effects, until the arrival of the firefighters, who, in all cases, will be notified immediately.
- Regular meetings will be held and the different types of fire will be explained, as well as the methods of suffocation to all the staff of the work, and in particular to the company's safety crews

5. WORK TEAMS. MACHINERY

The R.D. 1215/97 of Minimum Safety Provisions Concerning the Use of Work Equipment establishes the basic requirements to be met in the use of existing work equipment on the work.

It is understood as a Work Equipment, any machine, tool and auxiliary mean to be used on site and that is not an individual protective equipment. This document proceeds to give rules of use of the main Equipment to be used.

All this equipment are included in the following points of this document, falling apart in two fields:

- Machinery: Earth working machines and other auxiliary machines.
- Auxiliary means: Auxiliary machinery, hand tools and auxiliary means (scaffolding, hand ladders, slings, etc.)

These rules of use complement the previous one related to the construction units to be implemented, in which the Work Equipment (machinery and auxiliary means) have been linked to use in each of them, so that the subcontractors responsible for the execution of such works can be provided with a copy of the information corresponding to their activity as of the work teams to be used.

In general, the following indications must be taken into account:

- The machinery will only be used by competent personnel, with appropriate training and authorization from the Work Director
- It shall be used in accordance with the manufacturer instructions, which must accompany at all times
- The machinery must be perfectly known by to the operators.

- The maintenance and preservation of the machinery will be made according to the manufacturer's instructions.
- At all times, the provisions of R.D. 1215/97 of July 18th on minimum Safety and Health Requirements for the use by team workers must be followed.

Machinery reception

- Upon its arrival to the work, each machine carries in its documentation folder the safety standards for the operators, which must be known by the operator.
- Upon its arrival to the work, each machine is equipped with a stamped extinguisher and with the revisions up to date.
- Each driver has the proper training for the machine to be operated safely and, if not, he will be replaced or properly trained.
- The machinery to be used on site shall be provided with anti-roll and anti-impact cabin.
- The cabins shall not have deformations as a result of any overturning.
- The machinery will be equipped with lights and horn or reverse system alarm, all of them in a correct state of operation.

5.1.MACHINES FOR EARTHWORKS IN GENERAL

RISK IDENTIFICATION

- Hit-and-run people
- Crash against other vehicles
- Truck overturning
- Rollover by load shifts
- Falls
- Trappings

SECURITY ELEMENTS

The earthworks machinery (from a general point of view) to be used in this work, will be equipped with the following means at full operation:

- Headlights forward
- Reverse gear headlights
- Turn warning flashers
- Front and rear position pilots
- Top front beacon pilots of the case.
- Servo brakes
- Handbrake
- Automatic reverse gear horn

- Anti-roll and anti-impact cabins
- In some special cases, it may also be necessary or them to be equipped with air conditioning, protective nets, etc.

ONSITE SAFETY STANDARDS

- Every day, before the start of the day, the proper operation of the engine, hydraulic systems, brakes, steering, lights, horns, tyres, etc. will be inspected in prevention of risks due to malfunction or breakdown.
- This daily inspection can prevent accidents by mechanical failure, tire burst and assimilable.
- The contractor will be responsible for monitoring the execution of the daily inspection.
- These forecasts should be considered in the performance function required of each machinery day by day. No one better than the Contractor, to fix at the time in the future Security Plan the most appropriate or reasonable review sequence.
- Earthworks machinery drivers will be handed the following preventive regulations.

SAFETY STANDARDS FOR EARTHWROKS MACHINERY DRIVERS

- The earthworks machines to be used in this work, shall be equipped with forward and reverse headlights, servo brakes, handbrake, automatic reverse horn, rearview mirrors on both sides, anti-roll and anti-impact safety gantry and an extinguisher.
- The earthworks machines to be used in the site will be inspected on the daily basis controlling the proper operation of the engine, hydraulic systems, brakes, steering, lights, reverse horn, transmissions, chains and tyres.
- The security officer (or qualified personnel), will draw up a daily document of the revisions that are made to the machinery that he will present to the Work Director.
- It is prohibited to work or remain within the range of the motion machinery, to avoid the risks of hit-and-run.
- During the break time of the machines, their environment will be marked with "danger signs", to avoid the risks from brake failure or by hit-and-run during their restarting. .
- Signs will be installed warning of the danger of resting in the shadow of earthworks machines. That must be specially taken into account in hot times when there are no other elements in the environment that cast shade. To avoid that problem, cast shadow elements must be placed on the work.
- It is prohibited to work with earthworks machinery in the vicinity of the power line until the conclusion of the installation is defined within this Safety and Health Plan, in the protection against electrical contacts.
- In the case of contact with power lines with the machinery, the driver shall remain motionless in his position and will seek help through the horns. Before any action is taken, the pneumatic train shall be inspected in order to detect the possibility of electric bridge with the ground. If possible, the driver will jump out of the machine without touching the machine and its surroundings.

- Machines in contact with power lines shall be signed off at a distance of 5 m., with the company that owns the line to make the necessary power outages and grounding to be able to safely change the position of the machine.
- Before the abandonment of the cabin, the driver will have to leave at rest, in contact with the pavement (the blade, scoop, etc.), put the handbrake and stopped the engine removing the ignition key in order to avoid the risks due to failures of the hydraulic system.
- The driver will not leave the machine if it is not completely immobilized.
- Walkways and access steps for driving or maintenance will remain clean of gravel, mud and oil, to avoid the risks of falling.
- The intention of the above standards is to achieve periodic cleaning of the machines.
- The transport of people on earthworks machines is prohibited in this work to avoid risks.
- The exception should be considered on machines equipped with a passenger seat or a specific position for the permanence of an assistant during work.
- Maintenance or repair of machinery with the engine running is prohibited.
- End-of-route safety stoppers shall be installed, before the cuts coronation, slopes or embankments, to which the machinery used in the earth works operations must be approximated, to avoid the risks of falling machinery.
- The internal circulation paths will be marked by banner´s rope and standard traffic signals.
- Setting-outs or measuring in areas where earthwork machines are operating is prohibited in this work. Before proceeding with those tasks, it will be necessary to stop the machinery, or to move it away.
- The collection of land less than 2 m. from the edge of the excavation (as a general rule) is prohibited.
- The ditch of the roads near the excavation cuts shall be delimited to a minimum of 2 m in order to avoid falling machinery due to overloading the edge of the slopes (or cuts).
- The tyre pressure of the tractors will be checked and corrected on the daily basis.

5.2.DUMPER

RISK IDENTIFICATION

- Hit-and-run people
- Crash against other vehicles
- Truck overturning
- Rollover by load shifts
- Falls
- Trappings

SECURITY ELEMENTS

The dumper trucks to be used in this work, will be equipped with the following means at full operation:

- Headlights forward
- Reverse gear headlights
- Turn warning flashers
- Front and rear position pilots
- Top front beacon pilots of the case
- Servo brakes
- Handbrake
- Automatic reverse gear horn
- Anti-roll and anti-impact cabins
- In some special cases, it may also be necessary or them to be equipped with air conditioning, protective nets, etc.

ONSITE SAFETY STANDARDS

- Every day, before the start of the day, the proper operation of the engine, hydraulic systems, brakes, steering, lights, horns, tyres, etc. will be inspected in prevention of risks due to malfunction or breakdown.
- This daily inspection can prevent accidents by mechanical failure, tire burst and assimilable.
- The contractor will be responsible for monitoring the execution of the daily inspection.
- These forecasts should be considered in the performance function required of each truck day by day. No one better than the Contractor, to fix at the time in the future Security Plan the most appropriate or reasonable review sequence.
- Dumper trucks drivers will be handed the following preventive regulations.

SAFETY STANDARDS FOR DUMPERTRUCK DRIVERS

- Get in and out of the truck using the stairs that the machine has. It will avoid falling.
- It is forbidden to go up and down by leaning on the tires, wheels or protrusions. It will avoid accidents.
- It is mandatory to climb up and down by holding the handles front-facing. It will prevent falls.
- It is forbidden to jump directly to the ground if it is not for imminent danger to you.
- It is forbidden to make "adjustments" with the motor is running. It will provoke trappings.
- It is forbidden to allow unauthorized people to access the truck. It will avoid accidents.
- It is forbidden to use the dumper truck in a break down situation. It must be repaired before resuming the work.

- Before starting the engine, or before leaving the cab, the driver must make sure he has installed the handbrake.
- It is forbidden to store fuels or greasy rags on the dumper truck, they may cause fires.
- In case of engine heating, the driver must avoid open the radiator cover directly.
- The driver must remember that the crankcase oil is hot when the engine is hot. It must be changed once it is cold.
- It is forbidden to smoke when handling the battery, it can catch fire.
- It is forbidden to directly touch the battery electrolyte with your fingers. If that is required, it must be done protected with rubber or P.V.C gloves.
- If the dumper truck's electrical system must be handled for any reason, the driver must disconnect the engine and remove the ignition key completely.
- It is forbidden to release the truck's brakes in the stop position if the previously the immobilization plugs have not been previously installed.
- If the engine must be started using another's battery, precautions to avoid sizzling must be taken. The driver must remember that battery liquids release flammable gases.
- The tire pressure must be constantly checked. Machines must work with inflation pressure marked by their manufacturer.
- In the air filling of the wheels, the driver must place himself after the tread, away from the connection point.
- If the driver experiences a wheel explosion while driving and it loses its direction, he must keep the steering wheel in the direction the truck is going.
- If the brake is blocked, the driver must avoid head-on collisions or other vehicles in his carrier, trying lateral rubbing as smoothly as possible or enter to soft ground.
- Before entering to the cabin, the driver must turn around the hole truck by walking and check if there is something or someone.
- If contact between the dumper truck and a power line is produced, the operator must stay at his point and ask for help through the horn. Once he is warned, he will leave the truck, descend down the ladder normally and from the last rung, jump as far as possible, without touching the dirt and truck at the same time, to avoid possible electric shocks. Besides, don't let anyone touch the truck, it is very dangerous.
- It is prohibited in this work, to work or to remain at distances less than 10 meters (as a general rule), from dumper trucks.
- The dumper trucks in the station will be marked by "danger signs".
- The load shall be watered superficially to avoid possible dusting.
- One of the most serious risks that must prevented is dust creation.
- The internal ways for land transport will be those marked by the contractor in the final Safety and Health Report.
- It is forbidden to give rise to improvisations, the driver must remember that any prevention must be considered in the Safety and Health Plan.
- Loading dumper trucks above the maximum load marked by the manufacturer is expressly prohibited to prevent overload risks.

- All dumper trucks to be hired in this work, will be in perfect condition of conservation and maintenance.

5.3.LOADER SHOVEL

RISK IDENTIFICATION

- Sliding the machine
- Running out of control
- Overturning the machine
- Fall of the shovel through slopes
- Crash against other vehicles
- Contact with power lines
- Interferences with urban infrastructures
- Fire
- Burns
- Trappings
- Projection of objects during the work
- People falling from the machine
- Hits
- Own and assembly noise
- Vibrations
- Derivatives of the work carried out in powdery environments
- Derivatives of works and extreme weather conditions

SECURITY ELEMENTS

- Rollover protection structure or object life-saving cab
- Fire extinguisher
- Seat belt
- Battery disconnected
- Non-slip strips attached to control cockpit access
- Rearview mirror
- Emergency brake for parking
- Locking joint and spoon
- The drivers of the loader shovel will be informed in writing of the following preventive regulations, before the start of work

PREVENTIVE RULES OF ACTION FOR LOADER SHOVEL DRIVERS

- In order to raise or descend to or from the loader shovel, the driver must use the steps and handles arranged for this function, avoid fall injuries.

- It is forbidden to climb using tires, covers, chains and fenders, it will avoid fall accidents.
- The driver must get on and off the machinery head-on by roasting with both hands; it is safer.
- It is forbidden to jump directly to the ground, if it is not for imminent danger to the driver.
- It is forbidden to make "adjustments" with the moving machine or with the engine running, it will avoid accidents.
- It is forbidden to allow unauthorized people to access the machine.
- It is forbidden to work with breakdowns. The driver must repair them first, then restart the job.
- To avoid injuries, the driver must rest the wedge on the ground, stop the engine, put the handbrake on and lock the machine and finally perform the service operations as needed.
- It is forbidden to store greasy cloths or fuel on the shovel, they may catch fire.
- In case of engine heating, the driver must remember not to open the radiator cover directly.
- The driver must avoid touching the anti-corrosion fluid.
- The driver must remember that the engine oil is hot when the engine is running. It must be changed only when it is cold.
- It is forbidden to smoke when handling the battery, it may catch fire.
- It is forbidden to smoke when fuel is supplied, it may become inflamed.
- It is forbidden to touch the battery electrolyte directly with your fingers.
- If the electrical system must be handled for any reason, the driver must disconnect the motor and remove the ignition key completely.
- While cleaning the machine, protection mask, jumpsuit, chuck and rubber gloves must be worn.
- Before welding hydraulic system pipes, the driver must empty and clean them with oil.
- If the machine must be started using the battery of another, the driver must take precautions to avoid sizzling the cables.
- Monitoring tire pressure and working with inflation at the pressure recommended by the machine manufacturer is mandatory.
- During the air filling of the wheels, the driver must position himself after the tread away from the point of connection. He must remember that a rubber duct or nozzle burst can turn the assembly into a whip.
- The internal circulation paths of the work shall be drawn and marked.
- Improvisation is not allowed
- The internal roads of the work will be checked in order to avoid softness and excessive mud that undermine the safety of the circulation of the machinery.
- Loader shovels without anti-roll cab protection installed (or safety gantry) will not be accepted for this work.
- The anti-roll cab guards for each shovel model will be those expressly designed by the manufacturer for that model.
- The protections of the roll-in cab shall not have deformations .

- All engine exhaust points shall be checked periodically to ensure that the driver does not receive gases from combustion in the cab. This precaution shall be exercised in the motors equipped with a suction fan for the radiator.
- The loader blades in this work will be equipped with first aid kit, located in a safe manner to keep it clean internally and externally.
- The loader blades of this work, which must transit by public roads, will comply with the legal provisions necessary to be authorized.
- Drivers are not allowed from leaving the machine with the engine running.
- Drivers are not allowed from leaving the shovel with the spoon hoisted and without supporting the floor.
- The spoon during land transports will remain as low as possible in order to move, with maximum stability.
- Ascents or descents in charge of the spoon will always be made using short gears.
- Movement on uneven terrain shall take place at a slow speed.
- It is prohibited to transport people inside the spoon.
- The loader blades to be used in this work, will be equipped with a fire extinguisher, ringing and with the revisions up to date.
- The driver must wear the appropriate clothes.
- It is forbidden to get on or off the running shovel.
- The loader blades to be used in this work will be equipped with lights and reverse gear horn.
- It is forbidden to start the engine before making sure that there is no one in the operating area of the shovel.
- It is expressly forbidden to sleep under the shadow projected by the loader blades at rest.
- Drivers will ensure that there is no danger to workers inside wells or ditches near the excavation site.
- The drivers, before making 'new routes', will walk the way in order to observe irregularities that may give rise to vertical or horizontal oscillations of the spoon.
- Sudden oscillations and braking can lead to machine imbalance.
- The handling of heavy loads under strong winds conditions is prohibited.

5.4.COMPRESSOR AND PNEUMATIC HAMMER

a) COMPRESSOR RISK IDENTIFICATION

- Noise
- Pressure hose breakage
- The derivatives of the fume of toxic gases by exhaust from the engine
- Trapping during maintenance operations
- Compressor drop due to work in areas near edges

b) PNEUMATIC HAMMER RISK IDENTIFICATION

- Vibrations in members and internal organs of the body
- Occasional noise
- Noise
- Environmental dust
- Exertion
- Hose breakage under pressure
- Contacts with electrical energy
- Projection of objects and/or particles
- The derivatives of the workplace location
- Drops at different levels
- Falling objects over other places
- Collapses of the object (or terrain) treated with the hammer
- Derivatives of the works and machinery of your environment

STANDARDS OF ON-SITE INTEGRITY

- Improvisations should not be allowed, preventing them from being located in unforeseen or unsafe areas due to land accidents.
- Direct drag for compressor location by operators shall be carried out at a minimum distance of 2 meters (as a general rule), from the coronation edge of cuts and slopes, in prevention of the risk of slope detachment due to overloading
- Consider that such maneuvers carried out in the vicinity of cuts, ditches, etc., in the land, have caused fatal accidents by overturning with drag and trapping of people.
- Transport in suspension shall be carried out by slinging at four points of the compressor in such a way as to ensure the safety of the load.
- The compressor to be used in this work, will be in placed with the drag lance in the horizontal position, with the wheels fastened by anti-slip plugs.
- The protective housings of the compressor to be used in this work will always be installed in the closed position, in prevention of possible entrapments and noise.
- The area dedicated to this site for the location of the compressor will be cordoned off within a radius of 4 m. (as a general rule), in its environment, with signs of "mandatory the use of hearing protectors" to exceed the limiting line.
- Operators must keep in mind that in the area indicated, and outdoors, intensities between 90 and 100 dBA have been measured.
- Compressors (non-silent), to be used in this work, shall be located at a minimum distance from the hammer slash (or vibrators), not less than 15 m., (as a general rule).
- Operators must keep in mind the possibility of the connection of noise between hammer and compressor when setting this distance.
- Fueling operations shall be carried out with the engine stopped, in order to prevent fires or explosions.

- The hoses to be used in this work, will always be in perfect conditions of use: without cracks or wear that can predict a blowout.
- The safety officer will monitor the condition of the hoses, communicating the deterioration detected daily in order to be re-assembled.
- The connection or splicing mechanisms shall be received to the hoses by pressure fittings according to calculation.
- Operators must avoid hose-connection splices fastened with wires, loops and the like, unsafely.
- Pressure hoses shall remain raised to 4 (or more) meters high at junctions on the roads of the site.
- Avoiding the passage of pressure hoses over factory or rock debris as much as possible will eliminate risks of accident from accidental explosions.

5.5. VIBRANT ROLLER

RISK IDENTIFICATION

- Outrage
- Machine running out of control
- Machine shifts
- Fall through slopes
- Crash against other vehicles
- Fire
- Burn
- Falling people when getting on or off the machine
- Noise
- Vibrations
- Derivatives of continuous and monotonous works
- Derivatives of work carried out in harsh weather conditions

SECURITY ELEMENTS

- Follow-up brake and parking
- Rearview
- Poster indicator forbidden to stay within the radius of action of the machine
- Rotating flashing light signal for use in areas of poor visibility
- Fire extinguisher

SAFETY STANDARDS FOR DRIVERS

- It is a dangerous machine, so only experienced drivers must perform jobs with this machine.

- To get on or off the cab, use the steps and handles arranged for such a need. It will avoid falls and injuries.
- It is forbidden to access the machine by perching on the rollers, in order to prevent suffering falls.
- It is forbidden to jump directly to the ground if it is not for imminent danger.
- It is forbidden to make "adjustments" with the moving machine or with the engine running, it will provoke injuries.
- It is forbidden to allow access to the compactor of outsiders and less to its handling.
- It is forbidden to work with the breakdowns. Firstly, it must be fixed, then the operator will be able to resume his work. Taking unnecessary risks must be avoided.
- To avoid injury during maintenance operations, the operator must put the handbrake, block and machine into service, stop the engine by removing the ignition key. Then, perform the service operations that are required.
- It is forbidden to store fuel or greasy cloths on the machine, fires may occur.
- It is forbidden to lift the hot radiator cover. Uncontrolled gases can cause severe burns.
- Protection with gloves is required if for any reason the driver must touch the anti-corrosion fluid.
- The oil of the engine and its hydraulic system must be checked. It will prevent burns.
- Battery liquids release flammable gases. I
- If the electrolyte (battery liquids) must be touched, the operator must do it protected with waterproof gloves. Remember, the liquid is corrosive.
- If the electrical system must be handled, the operator must stop the motor and disconnect it by removing the ignition key.
- Before welding hydraulic system pipes, the operator must empty and clean them with oil. The oil in the hydraulic system is flammable.
- It is forbidden to release the machine brakes in the stop position if you have not previously installed the roller immobilization plugs.
- Before starting each work shift, check with slow maneuvers that all controllers respond perfectly.
- Adjust the seat to the driver needs, reach the controls with less difficulty and get less tired.
- The driver must wear personal protective clothing indicated by the safety manager of the site.
- The driver must always check, before boarding the cab, that there is no person around the machine.
- The compactors to be used in this work will be equipped with anti-roll and anti-impact booths.
- The roll-in cabs shall be those indicated specifically for this machine model by the manufacturer.
- The roll-in booths used shall not have deformations for having resisted any overturning.
- The compactors to be used in this work will be equipped with a first aid kit, located in a safe way to keep it clean.
- The abandonment of the vibrating roller with the engine working is expressly prohibited.

- The transport of non-driving people on the vibrating roller is prohibited.
- Access to driving with unsuitable clothing, chains, bracelets, rings, watches, is prohibited because they can be hooked on the protrusions or controls.
- The vibrating rollers used in this work, will be equipped with front and reverse lights.
- The permanence of operators in the slice of vibrating rollers, in the prevention of hit-and-runs, is prohibited.

5.6.MOTOGRADER

RISK IDENTIFICATION

- Skin injuries
- Physical burns
- Crushing
- Trappings
- Assaults and/or collisions
- Falling objects and/or machines
- People falls at the different level and from the machine
- Direct electrical contacts
- Indirect electrical contacts
- Hits and/or cuts with objects and/or machinery
- Vibrations
- Over-efforts
- Noise

SECURITY ELEMENTS

- Fire extinguisher
- Lighting for self-sufficient night work
- Non-slip strips attached to access
- Anti-roll protection structure or anti-fall cabin of objects
- Rearview mirror
- Parking or emergency brake
- Seat belt

PREVENTIVE STANDARDS FOR THE MOTOR GRADER OPERATOR

- It shall be ensured at all times the position of the blade, depending on the conditions of the terrain and the phase of work in operation.
- It will always circulate at moderate speed.

- The horn will be used when it is necessary to make sure that people know its presence. It will also be necessary to use the horn when the reverse gear is going to be used.
- Before leaving the machine, the driver will ensure that it is braking and cannot be commissioned by someone else.
- The driver will wear a helmet whenever you are outside the cab.
- It will take proper care of the machine, realizing faults or faults that it warns, interrupting the lock whenever these failures affect brakes or direction, until the fault is fixed.
- Maintenance and repair operations will be done with the machine stopped and with the blade resting on the ground.
- The permanence of people in the working in the area of the machine shall be prohibited.
- Extreme precautions against slopes and ditches must be taken.
- When moving, always circulate with caution, with the blade raised, without exceeding the width of the machine.
- It is forbidden to allow people, machines, and vehicles access to the machine's work area without prior notice.

5.7.CONCRETE MIXER TRUCK

RISK IDENTIFICATION

- People's hit
- Collision with other machines
- Overturning the truck (irregular, muddy, etc.)
- Fall inside a trench (cuts of slopes, half slope, etc.)
- People fall from the truck
- Blows by the handle of the gutters (pushes to the guide operators that may fall)
- Falling objects on the driver during pouring or cleaning operations.
- Blows from the concrete cubicle
- Trappings during the deployment, assembly and disassembly of the gutters
- Derivatives of contact with concrete
- Over-efforts

SECURITY ELEMENTS

- Adaptation of non-slip blades on the ladder to the loading hydrant of the concrete bass drum
- Multipurpose fire extinguisher
- Stop for parking during concrete construction, being the responsibility of the driver its placement

SAFETY STANDARDS ON SITE

- The access ramps to the cuts shall not exceed the slope of 20% (as a general rule), in the prevention of blocks or overturning of concrete trucks.

- Concrete stoppers to plugs shall be established, in prevention of overturning and falling during approach maneuvers for pouring.
- The cleaning of the tank and gutters will be carried out in the places indicated for such work, in the prevention of risks by carrying out work in nearby areas.
- Prevent people outside the work from remaining exposed to unnecessary risks.
- The staging and movements of the concrete truck during the pouring operations, will be directed by a signer, in prevention of risks for incorrect maneuvers.

SAFETY STANDARDS FOR CONCRETE TRUCK OPERATOR

- The instructions given to the driver according to the concrete spill must be strictly followed.
- The driver must respect the internal traffic signs of the work
- When the driver has to leave the truck cab, he must use the safety helmet.
- The checking indicated in the maintenance standards must be carried out.
- Before starting, it will be checked if the gutter is collected and securely fastened.
- It will be avoided to circulate in the vicinity of ditches or slopes to avoid collapses or overturns.
- After washing the truck or driving in in-watering places the driver should check the proper functioning of the brakes.
- Before getting out of the vehicle, the driver will break and with a gear when the engine stops.
- The driver will not leave the vehicle on steep ramps or near ditches. In case of need it, the machine will fit it properly and well-braked.
- During the pouring of concrete into wells and ditches, the driver will ensure that the gutter does not hit the operators working inside.

5.8.BACKHOE

RISKS IDENTIFICATION

- Sliding the machine
- Machine running out of control
- Overturning the machine
- Fall by slopes
- Crash against other vehicles
- Contact with overhead or buried power lines
- Interferences with urban infrastructures
- Fire
- Burns
- Trappings
- Projecting objects

- People falls from the machine
- Hits
- Own and environmental noise
- Vibrations
- Derivatives of the work carried out in dusty environments
- The derivatives of the work under extreme weather conditions
- Derivatives of the operations necessary to rescue buckets trapped inside the ditches

SECURITY ELEMENTS

a) Backhoe on wheels

- Non-slip strips on the accesses when the step is smooth
- Supporting elements
- Parking or emergency brake

b) Track backhoe

- Object lifeline
- Fire extinguisher
- Seat belt
- Battery disconnector
- Radio risk announcer poster around machine
- Non-slip strips on the top roller guards
- Rearview mirror

PREVENTIVE STANDARDS IN THE SITE

- It shall be dimensioned to a distance equal to that of the maximum range of the backhoe arm, the machine environment. The work or permanence of people is prohibited in the area.
- Keep in mind that these precautions should be exercised in the presence of other machines; especially backhoes working in parallel. A signer operator in these circumstances can be very useful.
- The internal roads of the work will be checked before its use in order to prevent blockings due to excessive softness and sweeps.
- Backhoes without anti-roll cabins will not be allowed in this work
- The anti-roll cabs shall be exclusively those indicated by the manufacturer for each model of backhoe to be used.
- All engine exhaust points shall be checked periodically to prevent harmful gases from being received in the cab.
- The backhoes to be used in this work will be equipped with a portable first aid kit, located in a safe manner to keep it clean.

- In this work, drivers are prohibited from leaving the backhoe with the engine running, to avoid the risk of hit-and-run.
- It is prohibited in this work for drivers to leave the backhoe without having previously deposited the spoon on the ground.
- It is forbidden to move the backhoe, if it has not been rested on the machine the spoon before, in avoidance of swinging.
- Ascents or descents of the spoons in loads will be done slowly.
- The transport of people on the backhoe in the prevention of falls, shocks, etc. is prohibited.
- It is forbidden to use the articulated arm or spoons to raise people and access specific jobs.
- The backhoes to be used in this work will be equipped with a fire extinguisher, ringing and with the revisions up to date.
- The backhoes to be used in this work will be equipped with lights and recoil horn.
- Earthworks maneuvers are prohibited without first having put the hydraulic immobilization supports into service.
- The handling of large loads (full-filling spoon), under a high wind regime, is expressly prohibited in this work.
- The spoon will have on its rear exterior an expressly welded hoop, to perform hangs.
- The tube shall be suspended from the ends (two points), in a position parallel to the ditch axis, with the machine set in the direction of the trench and on its leader.
- The load will be guided by capes handled by two operators.
- The maneuver will be led by a specialist.
- In case of insecurity of the ditch walls, work will be immediately stopped.
- Stresses above the backhoe's payload limit are prohibited.
- The backhoe will be repositioned by placing the arm in the direction of travel (except at very short distances).
- The repositioning of the backhoe in half-hillside work shall be carried out by placing the arm towards the top of the slope in order to increase the stability of the machine as far as possible.
- It is prohibited to park the backhoe less than three meters (as a general rule), the edge of ravines, holes, ditches and assimilable, to avoid the risk of overturns due to ground fatigue.
- Work inside the trenches in the range of the retro arm is prohibited.
- It is prohibited to pour the products of the excavation with the retro less than 2 m. (as general rule), from the cut edge.

PREVENTIVE RULES OF ACTION FOR BACKHOE DRIVERS

- To get on or off the backhoe, the driver must use the steps and handles arranged for such a need, avoiding in this way injuries from falls.
- The driver must avoid accessing to the machine by perching through tires, tires (or chains), and fenders, will prevent falls.
- The driver must get up and down the machine front (looking at it), holding with both hands.
- The driver must avoid jumping directly to the ground if it is not for imminent danger to your person.

- It is forbidden to make "adjustments" with the moving machine or with the engine running.
- It is forbidden to allow access to the backhoe to unauthorized people.
- It is forbidden to work with the backhoe in semi-livery situation (with sporadic failures). Repair it first, then resume work.
- To avoid injury during maintenance operations, first rest the spoon on the ground, stop the engine, put the handbrake into service, and lock the machine; then perform the service operations as you need.
- It is forbidden to store fuel or greasy cloths in the backhoe can catch fire.
- It is forbidden to heat up the radiator cover. Uncontrolled gases can cause burns.
- The driver must protect himself with gloves if for any reason he must touch the anti-corrosion fluid.
- Change engine oil and cold hydraulics to prevent burns.
- Battery liquids release flammable gases. If you must manipulate them, do not smoke or draw fire.
- If the driver has to touch the electrolyte (battery liquid), he must do it protected with gloves.
- If the driver wants to handle in the electrical system, he must disconnect the machine and first remove the ignition key.
- Before welding hydraulic system pipes, empty and clean them with oil.
- It is forbidden to release the machine brakes in the stop position if the driver has not previously installed the wheel immobilization plugs.
- If the driver must start the machine, using the battery of another vehicle, he must take precautions to avoid sizzling the cables. He must remember that electrolytes emit flammable gases.
- Monitoring tire pressure and working with inflation at the pressure recommended by the manufacturer of the backhoe is mandatory.
- During the air inflated of the wheels, the driver must position away from the connection point.
- Before starting each work, the driver must shift, it will prevent accidents when operating the controls correctly.
- The driver must adjust the seat in order to be able to reach the controls without difficulty; will get less fatigued.
- All control operations for the proper functioning of the controls must be done on extremely slow gears. In this way the driver will avoid accidents.

5.9.BULLDOZER

RISKS IDENTIFICATION

- Uncontrolled tractor slides
- Machines running out of control
- Bulldozer overturn

- Fall by slopes
- Collision against other vehicles
- Contact with electrical lines.
- Fire
- Burns
- Trappings
- People falls from the machine
- Hits
- Projecting objects
- Own and environmental noise
- Vibrations
- Derivatives of work carried out in powdery environments
- Derivatives of the realization of work in extreme weather conditions

SECURITY ELEMENTS

- Rollover protection structure or object lifeline
- Fire extinguisher
- Seat belt
- Battery disconnector
- Prohibited to remain within the radius of action of the machines sign
- Non-slip strips attached to the shovel arm for cab access
- Rearview mirror

RULES OF PREVENTIVE ACTION FOR BULLDOZER DRIVERS

- To raise or lower the bulldozer the driver must use the steps and handles arranged for such a need; it will avoid fall injuries.
- It is forbidden to access the machine by perching through tires, covers (or chains), and fenders.
- It is forbidden to the ground if it is not for imminent danger to your person.
- It is forbidden to attempt to make "adjustments" with the moving machine or with the engine running.
- It is forbidden to allow access to the bulldozer of unauthorized people.
- It is forbidden to work with the bulldozer with breakdowns.
- To avoid injury during operations, first the driver has to support the blade on the ground, stop the engine, put the handbrake into service and lock the machine; then perform the service operations .
- It is forbidden to store fuel or greasy rags on the bulldozer, they may catch fire.
- It is forbidden to lift the radiator cover. Uncontrolled gases can cause burns.
- The driver must protect himself with gloves if for any reason he has to touch the anti-corrosion fluid.

- Change the engine oil and the cold hydraulic system to prevent burns.
- Battery liquids release flammable gases.
- If the driver wants to handle the bulldozer's electrical system, he must disconnect the motor and first remove the ignition key.
- Before welding hydraulic system pipes, empty and clean them with oil. Remember that the oil in the hydraulic system is flammable.
- It is forbidden to release the machine brakes in the stop position if the driver has not previously installed the wheel immobilization plugs.
- If the driver must "start the engine" using the battery of another machine, he must take precautions to avoid sizzling the cables.
- The tire pressure must be checked and work must be carried out with the inflation at the pressure recommended by the manufacturer of the bulldozer.
- When filling the air of the wheels, the driver must position himself after the tread, away from the connection point.
- Before starting each work, the driver must shift, check that the controllers are working properly.
- To avoid accidents, control operations of the work must be done with extremely slow gears.
- If the driver runs into electrical wires, he must not leave the machine, until he has interrupted the contact and removed the bulldozer from the place. Then he must jump, without touching the terrain (or object in contact with it) at a time.
- The internal trucks circulation will take care of the area in order to avoid excessive softness and sweeps, which can cause accidents.
- Bulldozers without the required cabin protection will not be allowed in this work.
- The roll-in cabs shall be exclusively those indicated by the manufacturer for each model of bulldozer to be used.
- The anti-roll booths mounted on the bulldozers to be used in this work shall not have deformations of having resisted any overturning.
- All engine exhaust points shall be checked periodically to prevent harmful gases from being used in the cabin.
- The bulldozers to be used in this work will be equipped with a portable first aid kit, located in a safe manner to keep it clean.
- In this work, drivers are prohibited from abandoning bulldozers with the engine running.
- The abandonment of the machine without having previously rested the blade and scarified on the ground is prohibited. The bulldozers to be used in this work, will be equipped with a fire extinguisher, ringing and with the revisions up to date.
- Access to the bulldozers control cabin wearing unsuitable clothing and jewelry (chains, watches or rings) is prohibited controls is prohibited.
- It is forbidden to perch on the bulldozer during the realization of any movement. The bulldozers to be used in this work will be equipped with recoil lights and horns.
- It is prohibited to park the bulldozers in this work less than three meters (as a general rule), from the edge of (ravines, holes, trenches, ditches, etc.), to avoid the risk of overturns due to ground fatigue.

- Working is prohibited in the vicinity of the working bulldozers
- Before beginning the unloading process down the hillside, the area shall be carefully inspected, in prevention of landslides or avalanche on people or things.
- As a general rule, it will be avoided as far as possible, drive faster than 3 km./h when working with a bulldozer.
- As a general rule, the use of bulldozers in the areas of this work with slopes of around 50% is prohibited.
- In the prevention of sliding rolls, the upper edges of the slopes to be worked will be signposted, locating the signals at a distance not less than 2 m. (as a general rule) of the edge.
- Before the start of work with the bulldozers, at the foot of the slopes already built, those materials (trees, shrubs, rocks), unstable, that could be accidentally released on the cut, will be inspected. Once healed, the machine works will be started.

5.10. CONCRETE PUMPS ON TRUCK

INSTRUCTIONS FOR USE

- This equipment should only be used by authorized and duly trained personnel, with appropriate specific training.
- The operation of the brakes and the direction of the truck must be checked.
- The tire pressure must be checked.
- The for leaks in the fuel and cooling hydraulic circuits must be checked.
- The correct operation of the emergency disconnect button must be checked.
- The perfect operation of all control and control devices must be checked.
- It must be checked that there are no power lines, telephone lines or other obstacles in your work area that may trip over the pen.
- The operator must go to the designated area as a parking space.
- The operator must park the truck with the pickup pen and parking brake on.
- The operator must remove the ignition key and store it in a safe place.
- The operator must store the remote control in the cab.
- The operator must leave the cab locked.
- The operator must make sure that all vehicle documentation is in order.
- The operator must check the proper functioning of the brakes, steering signaling system and lighting.
- The operator must check tire pressure.
- The operator must check that the support legs are locked.
- The operator must watch the circulation code scrupulously.

If the operator/driver notice any abnormalities during the use of the machine, he must immediately report it to his superior.

RISK IDENTIFICATION

- Personal injury
- Machine overturning
- Spills
- Trappings
- Hits

PREVENTION MEASURES

- It is forbidden to remain under the area where the pen is acting.
- It is forbidden to put the hand of the moving parts of the machine (agitator, plungers, etc.)
- In the deployment and extension areas of the support legs there is a danger of crushing. The operators have to make sure that people do not approach the risk zone during this maneuver.
- The operators must always wear protective goggles when they are in the area of the concrete outlet hose or are handling in hydraulic circuits under pressure.
- When disconnecting a hose from the hydraulic circuit operators must think that it may be under pressure or with hot oil in order to take appropriate precautions (depressurize the circuit and wait for it to cool down).
- When concreting there are risks provoked by uncontrolled shakes of the hose.
- When positioning to pump, the truck must be perfectly level, using the stabilizing jacks. The maximum inclination allowed in any direction is 3 degrees.
- The support legs should be fully extended and rested on wooden or metal shells to spread the pressure to the ground evenly. The support base of the field-based fit should be flat and compact.
- It is forbidden to circulate with the boom unfolded, it greatly affects the stability of the truck.
- The truck must always drive on the construction roads at low speed respecting the signs.
- Never rest a leg on the edge of an embankment, the minimum distance should be 2 m from its edge.
- In case of storm or windy conditions, return the pen to the carrying position.
- Before moving the truck, the driver must make sure that the area is detached in the face of a possible hit-and-run.
- The boom must not be used to lift loads.
- It is forbidden to disassemble the pump grille covering.
- It is forbidden to prolong the terminal hose of the pen.
- Adjustable devices (pressure limiting valve, potentiometer, cylinder limiters, etc.) can only be handled by expressly authorized personnel.
- The works must always wear protection.
- Operators must take precautions when loading fuel.
- The machine must be operated from the driver's station. If operated from the remote control, the cab must remain closed to prevent the motor from starting up by third parties.

- Never move away from the machine if the engine is running or there is a possibility that someone may start it without authorization.
- Never leave the remote control out of your sight. If you have to leave him under any circumstances, keep him under lock and key.

5.11. CRANE ON PEN TRUCK

INSTRUCTIONS FOR USE

- This equipment should only be used by authorized and trained personnel.
- It is important to make sure that all vehicle documentation is in order. (Insurance, Driving Permit, Data Sheet, ITV, etc.)
- When driving this vehicle, it is important to respect the circulation code and provisional construction signage scrupulously.
- The operator must check for leaks in the fuel and cooling hydraulic circuits.
- The operator must check the tire pressure and the correct operation of the crane controls.
- The operator must go to the designated area as a parking space.
- The operator must park the truck with the parking brake on and the crane folded.
- The operator must remove the ignition key and store it in a safe place, leave the cab locked.
- If the operator notice any abnormalities during the use of the machine, he must immediately report it to your superior

RISK IDENTIFICATION

- Objects drops
- Abuses
- Shocks
- Overturns
- Fire and explosion prevention

PREVENTION MEASURES

- Before raising a load, the operator must make sure it is securely fastened.
- Load clamping elements (slings, hooks, shackles, etc.) shall have sufficient capacity to withstand the loads to be handled and must be in perfect storage condition
- When the operator is handling a load, no person should be placed within the radius of action of the crane
- It is forbidden to rotate the load before raising it
- During the entire maneuvers the crane operator must visually control the load. In the event that it is not possible ,a manager will give the orders by means of signals that must be known perfectly in advance

- If there are personnel near the vehicle, the operator must tap the horn before starting
- Before doing a reverse maneuver, the operator must look through the rearview mirrors
- When working with the crane, fully extend the stabilizing jacks (support legs)
- Before handling any load make sure the crane is correctly level.
- Make sure that the support legs are located on very firm ground, otherwise place thick planks or metal sheet under them to ensure the stability of the machine. Never rest the legs on the edge of a trench or embankment, the minimum distance should be 2 m. from the edge of it.
- When the crane meets the stabilizing jacks in the working position, the truck tires must not be in contact with the ground
- It is forbidden to circulate with the pen unfolded. When moving, the pen should be picked up as much as possible
- It is forbidden to attempt to lift any weight that exceeds the crane's maximum load capacity, loads attached or attached somewhere. Never pull them in an oblique sense
- Periodically check the operation of the load-time and end-of-run limiters of the hook
- All fuels are flammable.
- It is forbidden to smoke when refueling, or in areas where batteries are charged, or store flammable materials.
- It is forbidden to check the battery level with a lighter or match burn, the gases it releases are explosive.
- Avoid having rags impregnated with grease or other flammable materials inside the machine.
- Clean up oil or fuel spills, do not allow flammable materials accumulation the machine.
- It is forbidden to weld or blow through pipes that contain flammable liquids.
- Before unfolding the pen, the operator must make sure that there are no power lines, telephone lines or any kind of obstacle that may interfere with the crane. If there are any high voltage lines there must be at least a free distance of 5 m. between the top end of the crane and the line.

5.12. TANK TRUCK

RISKS

- Hit-and-run people
- Crash against other vehicles
- Truck overturning
- Spills
- Falls
- Trappings

SECURITY ELEMENTS

The tank trucks to be used in this work, will be equipped with the following means at full operation. In the event in which the tank is implemented in another machine, these security elements must be satisfied in general.

- Headlights forward
- Reverse gear headlights
- Turn warning flashers
- Front and rear position pilots
- Top front beacon pilots of the case
- Servo brakes
- Handbrake
- Automatic reverse gear horn
- Anti-roll and anti-impact cabins
- In some special cases, it may also be necessary or them to be equipped with air conditioning, protective nets, etc.

ONSITE SAFETY STANDARDS

- Every day, before the start of the day, the proper operation of the engine, hydraulic systems, brakes, steering, lights, horns, tyres, etc. will be inspected in prevention of risks due to malfunction or breakdown.
- This daily inspection can prevent accidents by mechanical failure, tire burst and assimilable.
- The contractor will be responsible for monitoring the execution of the daily inspection.
- These forecasts should be considered in the performance function required of each truck day by day. No one better than the Contractor, to fix at the time in the future Security Plan the most appropriate or reasonable review sequence.
- The tank will be inspected every day in order to check if there are some cracks. Besides all the sprinklers will be checked too in order to prevent obturations.

SAFETY STANDARDS FOR TANK TRUCKS DRIVERS

- Get in and out of the truck using the stairs that the machine has. It will avoid falling.
- It is forbidden to go up and down by leaning on the tires, wheels or protrusions. It will avoid accidents.
- It is mandatory to climb up and down by holding the handles front-facing. It will prevent falls.
- It is forbidden to jump directly to the ground if it is not for imminent danger to you.
- It is forbidden to make "adjustments" with the motor is running. It will provoke trappings.
- It is forbidden to allow unauthorized people to access the truck. It will avoid accidents.
- It is forbidden to use the tank truck in a break down situation. It must be repaired before resuming the work.

- Before starting the engine, or before leaving the cab, the driver must make sure he has installed the handbrake.
- It is forbidden to store fuels or greasy rags on the dumper truck, they may cause fires.
- In case of engine heating, the driver must avoid open the radiator cover directly.
- It is forbidden to smoke when handling the battery, it can catch fire.
- It is forbidden to directly touch the battery electrolyte with your fingers. If that is required, it must be done protected with rubber or P.V.C gloves.
- If the tank truck's electrical system must be handled for any reason, the driver must disconnect the engine and remove the ignition key completely.
- It is forbidden to release the truck's brakes in the stop position if the immobilization plugs have not been previously installed.
- If the engine must be started using another's battery, precautions to avoid sizzling must be taken. The driver must remember that battery liquids release flammable gases.
- The tire pressure must be constantly checked. Machines must work with inflation pressure marked by their manufacturer.
- In the air filling of the wheels, the driver must place himself after the tread, away from the connection point.
- If a spill is detected, all the electrical system must be turned off.
- If the driver experiences a wheel explosion while driving and it loses its direction, he must keep the steering wheel in the direction the truck is going.
- If the brake is blocked, the driver must avoid head-on collisions or other vehicles in his carrier, trying lateral rubbing as smoothly as possible or enter to soft ground.
- Before entering to the cabin, the driver must turn around the hole truck by walking and check if there is something or someone.
- If contact between the tank truck and a power line is produced, the operator must stay at his point and ask for help through the horn. Once he is warned, he will leave the truck, descend down the ladder normally and from the last rung, jump as far as possible, without touching the dirt and truck at the same time, to avoid possible electric shocks. Besides, don't let anyone touch the truck, it is very dangerous. In the event in which the hydraulic system ins working, it must be unplugged. Besides, before leaving the cabinet, the operator must check if the soil is wet. In that case, special measures will be taken.
- It is forbidden to give rise to improvisations, the driver must remember that any prevention must be considered in the Safety and Health Plan.
- Loading or filling tank trucks above the maximum load marked by the manufacturer is expressly prohibited to prevent overload risks and spills.
- If the tank is an implement, the connection must be checked before starting the operation.

5.13. SWEEPER

RISK IDENTIFICATION

- Overturning
- People's outrage
- Crashes on other vehicles
- Drops at the same/different level
- Particle projection
- Dust
- Vibrations
- Noise

SAFETY STANDARDS ON SITE

- The sweepers used shall be equipped with all the required safety mechanisms and shall be subject to periodic and correct maintenance.
- Precautions shall be exercised when working in the vicinity of the sweeper, to avoid the risks of hit-and-run.
- When leaving the machine remove the ignition key.
- The machine can only be occupied by one person.
- The machine dedicated to these works will be in perfect condition of maintenance and maintenance.
- The correct operation of the alert devices (horn, precautionary lighting, etc.) and check their safety conditions must be checked.
- The perfect view of the sweeper and the roadway must be checked.
- The absence of any deterioration in the hoses must be checked.
- Fuel, lubricant, cooling circuit and engine intake filter levels must be checked.
- It is forbidden to operate the engine in enclosed places without the installation of the exhaust pipe with outlet to the outside.
- Inspect around the machine, observing if there is anyone and checking for oil stains or other liquids on the floor for possible leaks.
- All safety and protection indications must always be kept well-readable and complete on the machine.
- The operator must have hearing protectors.
- It will not be swept away in areas where dust is dangerous to health.
- If by any circumstances the operator must get out of the vehicle, he must do so whenever possible, on the side where there is no circulation.
- To remove tangled objects (wires, etc.) from the machine, the appropriate working tools should be used.

6. MACHINE-TOOL

6.1.GENERATOR GROUPS

INSTRUCTIONS FOR USE

- This equipment should only be used by authorized and trained personnel.
- It is necessary to install a grounding before starting to work with the generator
- This equipment should always operate in an area with enough ventilation to prevent overheating
- Whenever possible, prevent water from falling directly onto the equipment
- The electric start should not be operated more than 20 seconds, if it does not start at this interval, wait at least one minute and repeat the operation

RISK IDENTIFICATION

- Injury
- Gasses emissions
- Fire
- Electrical shocks

PREVENTION MEASURES

- During the operation of the generator set, all protective covers and layers must be placed and closed.
- All maintenance operations must be done with the equipment stopped.
- Before changing oil or coolant, it must be checked that the engine is cold.
- During the operation of the generator set some parts of the generator (motor, exhaust duct) reach high temperatures, so it is important to avoid touching them.
- It is forbidden to start the generator set in enclosed places, without the installation of the exhaust pipe with outlet to the outside. Exhaust gases are harmful and can be fatal.
- Refuel operations must be only carried out with the engine stopped. The operator must be careful in filling and prevent spillage. It is forbidden to smoke during this operation.
- Check that there is no fuel loss, there is a risk of fire if any leakage is contacted with parts of the machine at high temperature.
- It is forbidden to check the battery by lightening with lighter or matches, the gases released by it are explosive.
- It is forbidden to start the machine with ether or any volatile liquid.
- It is forbidden to handle stressing elements
- It is forbidden to do connections directly to the terminals of the group, it must be done through the bases of the auxiliary box.
- It is forbidden to lean on the generator set or leave objects on it.

- It is forbidden to approach wearing very large clothing that can be attracted by airflow or trapped by moving elements.
- It is forbidden to repair the equipment if it there is not an expressly authorized to do so.
- If the operator performs any repairs or maintenance operations, he must bring the appropriate personal protective equipment to the job.

6.2.COMPRESSOR

INSTRUCTIONS FOR USE

- This equipment should only be used by authorized and trained personnel.
- The engine oil level must be checked when the compressor is in the horizontal position.
- The surface of the coolant must reach, in a cold state, the lower end of the immersion tube under the filling hydrant.
- Water from the facility and fuel tank must be purged daily.
- To avoid condensation of water vapor that accumulates at the bottom of the tank, it must be filled preferably at the end of the working day.
- When purging the compressor boiler, avoid particle projection into the eyes.
- When the oil level is checked or when it is filled with oil, the compressor must be in a horizontal position.
- The level should not fall below the average mark on the peephole.
- It must be ensured the correct operation of all control and indication lights.
- Turn the ignition key to the starting position.
- The engine should not stop suddenly when the machine is at full load. It should be allowed to run for about 3-5 minutes without load for temperature compensation.
- Breaks, alarm and signaling operation must be checked.

If the operator notice any abnormalities during the use of the machine, he must immediately report it to his superior.

RISK IDENTIFICATION

- Crushing
- Burns
- Noise
- Electrical contact
- Fire

REVENTION MEASURES

- Before starting the machine, the operator must read the service and maintenance instructions.

- Keep the safety labels installed on the machine must be kept clean. If some of them is lost it must be replaced.
- Wearing suitable work clothes is mandatory. Sometimes it is mandatory to wear glasses, certain footwear, helmet, gloves, reflective vest, protective headphones...
- In maintenance and repair work, the machine must be parked on firm ground, all levers must be placed in neutral position and the engine must be stopped by removing the ignition key.
- Never start the machine before securing loose parts.
- It is forbidden to make any additional modifications, extensions or assembly of equipment on the compressor, which will harm safety.
- The grease and oil compressor clean must be kept clean.
- It must be checked that the unloading media and subsequent transports in the cut are suitable.
- Special attention must be paid to the possible breakage of the spear, when towing.
- It is forbidden to work under the equipment as long as the equipment is not properly supported on the ground.
- When working with cables, the operators must wear gloves.
- Grids and protective plates that prevent contact with moving parts must remain in place, tightly adjusted
- It must be checked the cooling water level when the expansion tank cover cools down.
- At service temperature, the cooling system and engine oil are hot. There is a danger of burns.
- To perform battery work, the operator must wear safety goggles and gloves.

6.3.ELECTRICAL CONCRETE MIXER

INSTRUCTIONS FOR USE

- This equipment should only be used by authorized and properly trained personnel
- The machine will be installed on level ground and with enough resistance to prevent sinking of the wheels and support leg
- It is forbidden to unload the concrete mixer from the truck by throwing it directly to the ground, always use an auxiliary element
- It must be checked that the supply voltage corresponds to that indicated on the machine
- It must be started with the drum upright (face up))
- It must be checked that the drum rotation is correct
- At the end of the day the machine will be disconnected to prevent its start-up by an unauthorized person
- The drum must be washed on the daily basis with pressure water or some special concrete cleaning product

If the operator notices any abnormalities during the use of the machine, he must immediately report it to his superior

RISK IDENTIFICATION

- Trapping with moving elements
- Electrical shocks
- Harmful substances
- Projection of elements

PREVENTION MEASURES

- It is forbidden to operate the machine if the operator does not have drag belt protection.
- In combustion engine machines with no electric start, when grasping the crank, the thumb must be always put on the same side as the other fingers.
- It must be checked that the rotation of the starter crank does not interfere with other parts.
- The machine must always be connected to a frame with differential protection and grounding and through the corresponding standardized connector.
- In the concrete discharging, the drum must be tilted slowly to avoid splashing to the face or any other part of the body.
- The personal protective equipment must be used.

6.4. VIBRATORS

INSTRUCTIONS FOR USE

- This equipment should only be used by authorized and duly trained personnel.
- Wearing gloves and water boots, as well as work clothes to avoid contact with concrete, during vibrating work is mandatory.
- Using regulatory work platforms for high-altitude work whenever the situation requires it is mandatory.
- If the vibrator is electric, it must be checked that the generator set has the necessary electrical protections (ground, differential and magnetothermal pike).
- If it is powered by a small generator set, check that the condition of the terrain is appropriate (dry, without mud or moisture)
- If any operator notice any abnormalities during the use of the machine, he must immediately report it to his superior

RISK IDENTIFICATION

- Noise
- Electrical shocks
- Fire

PREVENTION MEASURES

- The condition of the vibrator hoses or cables must be checked to avoid electrical hazards or explosions.
- Prolonged exposure to vibrations must be avoided.
- It is forbidden to touch the armors as much as possible with the vibrator.
- It is forbidden to use vibrators in a malfunction or malfunctioning state to avoid accidents.
- The stairs to access the high-rise cuts must be used, it is forbidden to climb the formwork.

6.5. WELDER

INSTRUCTIONS FOR USE

- This equipment should only be used by authorized and duly trained personnel.
- Wearing gloves, overalls and a mask for eye´s protection is mandatory
- Using regulatory work platforms for high-altitude work whenever the situation requires it is mandatory.
- The distance between the welder and the operator must be the one indicated by the manufacturer.
- If any operator notice any abnormalities during the use of the machine, he must immediately report it to his superior

RISK IDENTIFICATION

- Fires
- Burns
- Electrical contacts
- Spark projection

PREVENTION MEASURES

- It is mandatory to wear assigned personal protective equipment (helmet, screen, gloves, sleeves, vest, and boots).
- The work area must be kept clean of any material susceptible to ignition with possible spark drop.
- It is forbidden to weld or cut a tank or container without making sure it is empty and degassed if flammable materials are contained.
- The liquefied gas warehouse shall be located on the outside of the work or far from structural elements, with direct and constant ventilation, on the access door equipped with a security lock or lock. The "Danger of explosion" and "Smoking Prohibited" signs will be installed.

- Liquefied gas welding lighters must be equipped with flame-resistant valves, in prevention of the risk of explosion.
- It is prohibited to collect or keep bottles of liquefied gases in the sun. They will be placed in the shade and in a vertical position at least 24 hours before use.
- Bottles of liquefied gases will be collected separately (oxygen, acetylene, butane, propane), with express distinction from storage places for the already depleted and filled.
- It must be periodically checked the condition of the hoses to avoid their use with leakage in them by deterioration.
- If the flame anti-return adhesion valve is observed and it has been possible to burn "inside" the cylinder, it will be inserted into a drum with water in order to cool it.
- Always use hoses in good condition
- Hose splicing will always be done using watertight weather connectors, they will never be done with insulating tape
- The clamp will not be left directly on the floor, when the work is interrupted it will rest on an insulating support (may be a piece of wood)
- When an operator must work at a height of more than two meters, he will be climbed on a scaffold with perimeter protection or inside a safety cage. He must wear a seat belt and fasten it to secure anchor points
- The work area must be well ventilated for the evacuation of fumes from the weld if it were not to be forced ventilation
- Extreme precautions when welding on painted or chemically treated objects
- In closed areas, mask with appropriate filters must be used
- The transfer and location for use of liquefied gas bottles shall be carried out by means of safety bottle carriers.
- Facial screens will be used at all times

6.6.MANUAL TOOLS AND HANDLADDERS

RISK IDENTIFICATION

- Electric shocks
- Particle projection
- Falls in height
- Noisy atmosphere
- Dust generation
- Explosions and fires
- Cuts on limbs

INSTRUCTIONS FOR USE

- All power tools will be equipped with double safety insulation and will be connected to a circuit with differential protection of 30 mA.
- The instructions for its use should be known to the personnel using these tools.
- The tools will be reviewed periodically, in order to check that the manufacturer's conservation instructions are complied with.
- The tools will be collected in the construction warehouse, taking them to it after the work is finished, placing the heaviest tools and the shelves closest to the ground.
- Tool disconnection operation will not be done with a sudden pull of the power cord.
- No power tool without plug will be used; if there is a need to use extension hoses, these will be made from the tool to the plug.
- Work with these tools will always be carried out in a stable position.
- Work areas will be kept clean and tidy.
- Power hoses will be in good use.
- The gaps will be protected with railings.
- The ladders will be kept clean

INDIVIDUAL PROTECTIVE EQUIPMENT

- Safety-approved helmet.
- Leather gloves.
- Hearing and eye protections in the use of nailing gun, firing drill, grazers.
- Seat belt for high-altitude jobs.
- Dust protection in those that release it (cutters, sanders).
- Tight workwear.

6.7.SLINGS AND CHAINS

INSTRUCTIONS FOR USE

- Only suitable resistant items shall be used.
- Support elements shall not be used by forming sharp angles or on sharp edges.

LIFTING TACKLE. HOOKS

- Under no circumstances the maximum load of use will be exceeded.
- It is forbidden to use old or deteriorated hooks.
- The safety latch must be in good condition.

CABLES

- Choose the right cable, with a suitable composition and enough load capacity for the operation to be performed.
- Check them frequently. Remove those who present:
  - Broken wires.
  - Worn wires.
  - Oxidations.
  - Deformations.
- Perform proper maintenance:
  - Cable development: If the cable comes in rolls, the right thing to do is to roll the roll. If it comes on the reel, it will be positioned so that it can rotate on its axis.
  - Wire cutting: The most practical method for cutting cable is by means of torch; a shear can also be used.
  - Cable grease: Grease reduces wear and protects the cable from corrosion.
  - Cable storage: Must be in dry and well-ventilated places, cables should not rest on the ground.

SLINGS

Slings are fundamental elements in the earthwork. Their use is so frequent in works that often cause accidents due to the breakage of these elements or the release of the load.

The gaze of the slings may be made by:

- Closed gaza with seams. The seams consist of interlacing of the cable laces. It must have enough resistance. They are the most used for the simple of their execution. The number of pins and the separation between them depends on the diameter of the cable to be used (Table 31).

Table 31: Number of pins and separation between them depending on the cable diameter to be used

Up to 12 mm	Nº of pins = 3	Distance = 6 Diameters
12 mm to 20 mm	Nº of pins = 4	Distance = 6 Diameters
20 mm to 25 mm	Nº of pins = 5	Distance = 6 Diameters
25 mm to 35 mm	Nº of pins = 6	Distance = 6 Diameters

- Gaza with pressed shell casings. It is characterized by the absolute closure of the two branches by means of a metal bushing.

CHOICE OF SLINGS

In order to correctly choose a sling, it shall be taken into account that the cable that constitutes it has:

- Enough load capacity. The maximum load depends mainly on the angle formed by the branches: the larger the angle, the smaller the load layer of the sling. It is forbidden to work with a sling with an angle greater than 90 degrees (correct angle).
- Composition of the sling cable. Very flexible cables must always be used, so metal soul cables are rejected. Another very important rule is that is forbidden to use of rounded ferralla to replace the slings.

USE OF SLINGS

For the properly use of the slings and strobes, the following notes must be taken into account:

- The settlement of the slings is essential.
- The sling crossing must be avoided.
- The right terminals must be chosen.
- The resistance of the hitch points must be ensured.
- The slings must be kept in good condition. They should not be left out in the open air, let alone lying on the ground. They must be hanged.

RISK IDENTIFICATION

- Suspension load drops by breaking of lifting elements.
- Suspension load drops due to poorly slinging of the load.

PREVENTION MEASURES

- Protect edges with rags, sacks or better with protective brackets.
- The terminal rings of the cables must be equipped with guards.
- It is forbidden to use rejected cables or chains.
- In the load to be raised, the points that do not allow the slings to slip will be chosen.
- The load will remain in stable equilibrium, using, if necessary, a gantry to balance the forces of the slings.
- The following measures shall be especially taken into account :
- When a sling has to be moved, it will loosen enough to be able to move it.
- A sling will not be moved by placing below the load.
- Loads will not rise sharply.

6.8.CIRCULATION SIGNALS, FENCES AND SPOTLIGHTS

INSTRUCTIONS FOR USE

- Only suitable and homologated items will be used.

- They will be settled in those places where and when necessary.
- They will be suitable for the purpose of its use.

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA AGRONÓMICA Y BIOCIENCIAS

NEKAZARITZAKO INGENIARITZAKO ETA BIOZIENTZIETAKO GOI MAILAKO ESKOLA TEKNIKOA

COUNTRY ROAD DESIGN BETWEEN MURILLO EL FRUTO I COUNTRY ROAD AND LAKUMULATU AREA IN UJUÉ (NAVARRA)

Requirements Document

-BASIC SAFETY AND HEALTH REPORT -

presentado por

Asier Gamallo Valls(e)k

aurkeztua

GRADO EN INGENIERÍA AGROALIMENTARIA Y DEL MEDIO RURAL
GRADUA NEKAZARITZAKO ELIKAGAIEN ETA LANDA INGURUNEAREN INGENIARITZAN

Junio, 2020 / *2020ko ekaina*

INDEX

1. INTRODUCTION

Preventive resources will be required. Such resources shall have a secure location which does not suppose an additional risk factor, either for such people or for the workers. Those resources shall remain in the work center for as long as the situation determining its presence is maintained.

At the beginning of this work Law 32/2007, Regulatory of Outsourcing in the Construction Sector, as well as RD 1109/2007 on the development of Law 32/2006, will come into force, so the implementing parties that are in force will be mandatory.

The provisions contained in the following rules and regulations will be complied compulsorily.

- Chapter XVI of the Labor Ordinance on Construction, Glass and Ceramics, (O.M. 28-8-70) (B.O.E. 51718/9-9-70).
- Collective Agreement on the Construction of Navarra.
- Law 8/1980, of March 1st, of the Workers' Statute.
- Complementary Technical Instructions.
- Order of May 23rd, 1977, approving the Regulations on Lifting Devices for Works.
- Royal Decree 1435/1992 of November 27th laying down the implementing provisions of Council Directive 89/392/EEC on the approximation of the laws of the Member States relating to machinery.
- Royal Decree 1407/1992, of November 20th,regulating the conditions for the marketing and free intra-Community movement of Dual Individual Protection Equipment (EPI).
- Royal Decree 1591/1995, of February 3rd, which modifies the Royal Decree 1407/1992, of November 20th, regulating the conditions for the marketing and intra-Community free movement of PPE'.
- Law 31/1995 on the Prevention of Labor Risks (B.O.E. 10/11/1995).
- Royal Decree 39/1997, of January 17th, approving the Regulations on Prevention Services (B.O.E. 31/01/97).
- Royal Decree 485/1997, of April 14th, on minimum provisions on signage (B.O.E. 23/04/97).
- Royal Decree 486/1997, of April 14th, laying down the minimum Safety and Health Requirements in workplaces (B.O.E. 23/04/97).
- Royal Decree 487/1997, of April 14th,on manual handling of loads involving risks, in particular backache, for workers (B.O.E. 23/04/97).
- Royal Decree 664/1997, of May 12th, on the protection of workers against risks related to exposure to biological agents during work (B.O.E. 24/05/97).
- Royal Decree 665/1997, of May 12th, on the protection of workers against risks related to exposure to carcinogenic agents at work(B.O.E. 24/05/97).
- Royal Decree 773/1997, of May 30th, on minimum Safety and Health Provisions relating to the use by workers of protective equipment (B.O.E. 12/06/97).

- Order of June 27th, which wears out R.D. 39/1997, in relation to the accreditation conditions of specialized entities, as prevention services outside companies (B.O.E. 4/07197).
- Royal Decree 1215/1997 of July 18th, laying down the minimum Safety and Health Requirements, for the use by workers of work equipment (B.O.E. 7/08/97).
- Royal Decree 1627/1997 of October 24th,which makes minimum Safety and Health Provisions set on construction sites.
- Resolution of April 8th, 1999, on Delegation of Faculties on Safety and Health in Construction Works, complements Article 18 of Royal Decree 1627/1997, of October 24th, 1997, on Minimum Safety and Health Provisions in Construction Works.
- Royal Decree 614/2001 of June 8th on minimum provisions for the protection of the Safety and Health of workers against electrical risk.
- Royal Decree 842/2002 of August 2nd approving the Electrotechnical Regulation for low voltage.
- Order TAS/2926/2002 of November 19th establishing new models for the notification of accidents and enabling their transmission by electronic procedure
- Bug fixes of Order TAS/2926/2002, of November 19th, which establish new models for the notification of accidents at work and enable their transmission by electronic procedure.
- Law 54/2003, of December 12th, on reform of the regulatory framework for the prevention of occupational risks
- Royal Decree 171/2004, of January 30th, which develops Article 24 of Law 31/1995, of November 8th, on the Prevention of Occupational Risks, in the field of coordination of business activities
- Royal Decree 2177/2004, November 12th, which lays down minimum Safety and Health Requirements for the use by workers of work equipment in the field of temporary work at high altitude.

2. SAFETY STANDARDS

2.1. TECHNICAL STANDARDS TO BE MET FOR THE STORAGE AND SIGNAGE OF PRODUCTS

Products such as solvents, paints, varnishes, adhesives, etc. and other dangerous products must be stored in ventilated places with the containers properly closed, and clean premises, away from ignition bulbs and properly signaled. The specific character and toxicity of each hazardous product shall be indicated by the characteristic hazard signal.

2.2. SAFETY STANDARDS APPLICABLE TO MACHINERY IN GENERAL AND DURING ITS MAINTENANCE

The machinery will have all the established prevention accessories, will be handled by specialized personnel, will be kept in good use, for which they will undergo periodic reviews and in case of breakdowns or malfunctions they will be paralyzed until being repaired.
The protection elements, both personal and collective, should be reviewed periodically so that they can effectively fulfil their function.
Lifting machinery shall be subjected to maintenance whose control will be carried through the Maintenance Book.
In all other machinery, the same type of control, technical inspections, etc. shall be carried out.

a) MACHINES IN GENERAL:

- Trepidation machine tools shall be equipped with absorption and damping mechanisms.
- Motors with drive through axles and pulleys shall be equipped with protective anti-trapping housings.
- Safety protective housings will allow the view of the protected object.
- Electric motors shall be covered by protective housings removing direct contact with electrical energy. It is prohibited to operate without housing or with major deterioration of it.
- Gears of any type of mechanical, electrical or manual drive shall be covered by protective anti-trapping housings.
- Machines with irregular or damaged operation will be removed immediately for repair.
- Broken machines that cannot be removed shall be marked with warning signs.
- The same person who installs the warning sign of "Broken Machine" will be responsible for removing it, in prevention of connection or commissioning in service out of control.
- Handling and adjustment and arrangement of machinery to non-specialized personnel specifically on the machine under repair is prohibited.
- As an additional precaution to prevent the commissioning of damaged or irregularly operated machines, the starters shall be blocked, or the electrical fuses shall be removed.
- In the case of power outage, the machine is recommended to be protected with an automatic disconnection device, so that when the supply is restored, the resetting of the machinery is necessary for commissioning.
- Only authorized personnel with specific written documentation will be responsible for the use of a particular machine.
- Non-manual-lifted machines shall always be supported on level and firm elements.

b) LIFTING MACHINES:

- The lifting or moving down of objects shall be carried out slowly, lifting them in vertical leader. Inclined jerking is prohibited.
- The hanging hooks of the lifting apparatus shall be free of charge during the resting phases.
- Loads in suspended transport will always be in sight of operators, specialized personnel, etc., in order to avoid accidents due to lack of visibility of the trajectory of the load.
- The angles without vision of the load path for the operator, specialized personnel, etc., will be supplied by operators who using pre-diagnosed signals supplant the vision of the aforementioned worker.
- Staying in zones under the trajectory of suspended loads is prohibited.
- The lifting devices to be used shall be equipped with a carriage travel limiter and hooks.
- Electric crane and forklift motors shall be equipped with height limiters and the weight to be displaced, which automatically cut off the supply or electrical to the motor when the load must be stopped when the load is going to be rotated or shifted.
- The lifting cables to be used in lifting and transporting loads shall be calculated according to the requests for which they are installed.
- The replacement of damaged cables shall be carried out by means of skilled labor.
- The cable loops shall always be protected internally by metal covers, to prevent deformations and shears.
- The clamping hooks shall be made of steel and shall be provided with a "safety latch".
- All lifting devices shall bear the maximum load they can bear.
- The lifting or transport of people inside cages, batteries, cups or assimilable is prohibited.
- All machines with power supply shall be equipped with grounding in combination with differential circuit breakers.
- It is prohibited to grease moving cables.
- Spare gasoline cans should not be stored inside the machinery booth.

c) EARTHWORKING MACHINES:

- Operators must be competent and qualified.
- Metal wires, drums and shackles should be checked periodically for wear and feel.
- All gears and other moving parts of machinery must be properly guarded.
- The steps and stairs must be in good condition.
- Adjust the machine cab seat according to the driver's characteristics.
- Use an automatic connecting nozzle to inflate the tires and place themselves behind them when inflating process is carried out.
- In the hydraulic machinery, the pressure indicated must never be altered.
- It is prohibited to make adjustments or repairs when the machine is in motion or with the engine running.
- The former digger will not be allowed to be used as a crane.

- The spoon shall not be used for the transport of materials.
- It is forbidden to enter the cabin to anyone other than the driver while working.
- It is forbidden to get out of the cab while the general clutch is engaged.
- It is forbidden to leave the loaded machine, either with the engine running, or with the spoon raised.
- Oily rags and other combustible materials must be stored in a safe place.
- Spare gasoline cans should not be stored inside the cab of machinery.
- A portable fire extinguisher and first aid kit should be placed on the machine in easily accessible locations. The machinist must be properly trained in its use.

2.3.STANDARDS FOR LIFTING, MOVING AND PLACING LOADS

a) PRINCIPLE OF OPERATION:

- Tight the cables after the load is hooked.
- Raise slightly, to allow the load to acquire its equilibrium position.
- Be sure that the cables do not skate and that the branches are laid equally.

b) LIFTING:

- The lifting movement must be performed alone.
- Make sure that the load will not hit with any obstacles when acquiring its equilibrium position.
- The raised object must be retained by wires or ropes.

c) DISPLACEMENT WITH LOADS:

- It should be done when the load is high enough to not encounter obstacles.
- If the route is large enough, the operator should transport at low altitude and moderate walking.
- The load must be moved in the light of the crane driver's view.

d) LOADING PLACEMENT:

- Operators should not be left suspended above a walkable area.
- The descent should be ordered only when the load has been frozen.
- Cables should not be tightened when depositing loads.

- The load that can be rolled must be placed, using fits with a thickness of 1/10 the diameter of the load.
- Special care will be taken not to load newly constructed floors or forgings with materials that may cause sinking.
- The floors or work platforms will not be loaded more than to the extent indispensable for the execution of the work, proceeding to the lifting of the materials according to these needs.

2.4.STANDARDS FOR THE OPERATION OF POWER TOOLS

- All machinery and power tools which do not have double insulation must be grounded.
- The circuit to which they connect must be protected by a switch, 30 milliamps sensitivity.
- Electrical cables, connections, etc. must be in perfect condition, being convenient to check them frequently.
- When useful, adjustments are made or repairs are made, they must be disconnected from the electrical circuit, so that there is no possibility of unintentionally starting them.
- If the operators need to use extension cables, connections should be made starting at the tool and following towards the power outlet.
- When using power tools in wet areas, there should be used with the degree of protection (IP) specified in the Low Voltage Electrotechnical Regulation.
- Portable power tools should never be left running if not in use. When resting on the ground, scaffolding, etc., they must be disconnected.
- Power tools (drill, rotaflex, etc.) should not be worn by hanging around the cable.
- When a portable power tool is passed from one operator to another, it should always be machine-fired and allowed to leave it on the ground for the other to take it and not hand by hand, for the danger of possible involuntary start-up.

3. SAFETY ORGANIZATIONON SITE

3.1.PREVENTIVE ACTIVITY ORGANIZATION BY THE CONTRACTOR

Following the Law 31/1995 on the Prevention of Occupational Risks and Royal Decree 39/1997 approving the Regulation of Prevention Services, the Contracting Company will have a service to prevent occupational risks in the specialties of Health, Safety, Hygiene, Ergonomics and Applied Psychosociology Surveillance.

3.2.PREVENTIVE ACTIVITY ORGANIZATION IN THE WORK

a) CONTRACTOR

Manager:

The Contractor Company shall designate a manager for each phase in which the work is as a representative with responsibility for safety and health on the site. He must have risk prevention training as set out in Article 19 of the Occupational Risk Prevention Law.
The manager will be in the work whenever work is being carried out, being a person of proven capacity for the position, with extensive practical knowledge of the construction. In case, if a worker have to leave the work, he will notify the construction manager well in advance to take responsibility for the cut in his absence.

The responsibilities that correspond him are the following:

- To enforce the Safety Standards, arousing the interest of workers for safety.
- To examine the Working Conditions for the purpose of determining actions that may bilious and endanger the Safety and Health of workers.
- To immediately communicate to the Work Head of risk
- To know, disclose and enforce the Security Plan, as well as the implementation of corrective instructions or measures transmitted to them by the Security Coordinator.

Work Head:

The contracting company will designate a Work Head for each phase in which the work is located. The Work Head shall periodically visit the work by transmitting the relevant instructions to the manager.
The construction managers will have courses of risk training as set out in Article 19 of the Prevention of Occupational Risks Law.

Prevention Technician:

The contracting company will have a Senior Technician in Occupational Risk Prevention of the occupational risk prevention service in order to advice on occupational risk prevention.
The Senior Technician in Occupational Risk Prevention will make weekly visits to the work to detect possible deviations from the Safety and Health Plan and will give, if needed, some measures to correct it.

Preventive Resource:

The contracting company shall appoint the Preventive Resources when one of the following circumstances occurs:

a) When special risk work is carried out, as defined and detailed in Annex II1 of the Royal Decree 1627/1997, and such risks may be aggravated or modified in the course of the process or activity, by various operations that develop successively or simultaneously and which make it necessary to monitor the correct application of working methods.

b) When performing any of the following activities or processes:

- Works with particularly serious risks of falling from height, due to the particular characteristics of the developed activity.
- Jobs at risk of burial or sinking.
- Activities using machinery without an EC declaration of conformity.
- Work in confined spaces.

c) When presence is required by the Labor and Social Security Inspectorate.

Preventive resources shall have enough capacity, have the necessary means and be sufficient in number to monitor compliance with preventive activities.

The contractor may assign the presence of one or more workers who, without being part of the self-prevention service or being designated workers, gather the necessary knowledge, qualification and experience in activities or processes with special risks and have the appropriate preventive training at least to the functions of the basic level.
The mandatory presence of preventive resources shall apply to each contractor.
The mandatory presence of preventive resources will have the aim of monitoring compliance with the measures included in the Safety and Health Plan in the work and verifying the effectiveness of these.
The employer shall provide his workers with the necessary data to identify the designated people as a preventive resource.
The location of the people designated as a preventive resource will enable them to fulfil their own functions, in a secure location and which does not pose an additional risk factor for them or the rest of the workers.
Preventive resources will remain in the workplace for as long as the situation that motivated their presence is maintained.

The preventive resource is competent to:

- Monitor compliance with the measures included in the occupational Safety and Health Plan and check their effectiveness.
- Dictate the necessary indications for the correct and immediate fulfillment of preventive activities.

- Inform the employer of the incidents.

b) SUBCONTRACTOR

Subcontracting companies shall adhere to the Safety and Health Plan and to Art. 7, 11.1B and 11.1C of DR 1627/97. The main Contractor and each subcontractor shall comply with the indications and comply with the instructions of the coordinator on safety and health during the execution of the work or, when appropriate, the optional management, as stipulated by Art 11.1 E of RD 1627/97.

4. WORKERS: RESPONSIBILITIES, RIGHTS AND DUTIES

- The general obligations and duties of workers in the sectors of activity, public or private, are all those that the legislation in force and the Convention grants them and between them:
- The duty to obey the employer's instructions regarding Safety and Health.
- The duty to indicate potential hazards.
- The responsibility of personal acts, as well as for reviewing and notifying any deficiencies that are observed both in the machinery they use and in the protective equipment.
- The right to receive adequate and understandable information and to forge proposals, in relation to Safety and Health, in particular on the Safety and Health Plan (PSS).
- The right to consultation and participation, in accordance with Article 18.2 of the Prevention of Occupational Risks Law.
- The right to address the competent authority.
- The right to interrupt the work in case of serious and imminent risk to its integrity, that of its companions, or third parties outside the work.

5. ACTIONS TO FOLLOW IN THE EVENT OF AN ACCIDENT

5.1.ACCIDENT PART

For each accident that occurred, even if it has been unregistered, a part will be filled in which the data of the worker, day and hour, injuries suffered, place where it occurred, machinery, maneuver or action causing the accident and rules or preventive measures to have to avoid its repetition will be specified.
The part must be made by the Work Responsible, being sent copies of it to the Work Head, Prevention Service and the Delegate of Prevention.
In case the accident has little incidence, the worker can choose not to perform the part.

5.2.ACTIONS TO FOLLOW

For the company, the accident at work is identified as a risk prevention failure due to several causes. Therefore, it is possible that, despite all the effort developed and the preventive intention, there will be some failure.
The company, through the Work Head, shall apply the following principles of relief in the event of an accident at work:

1st The injured worker comes first. He will be treated immediately in order to prevent aggravation or progression of injuries.
2nd In the event of a fall from a certain height and in the case of an electric accident, it shall always be assumed that serious injuries may exist, therefore the precautions of primary care in the work will be exercised, applying the special techniques for the immobilization of the accident worker until the arrival of the ambulance, and of resuscitation in the case of an electric accident.
3rd In case of manifesting serious injuries, the injured person shall be evacuated by stretcher and ambulance; there shall be avoided, as far as possible, in the good judgment of the who primarily attend the injured person, the use of particular transports, thus implying risk and discomfort for the injured.
4th The nearest care center will be: CHN in Pamplona
5th In order to be known to all people participating in the work, a series of labels with visible characters at 2 m. shall be installed, in which the necessary information is provided to know the care center, contact telephones etc.; this label contains the details in the following table (Table 32).

Table 32: Nearest Healthcare Centers

HEALTHCARE CENTER	TELEPHONE	ADRESS
Navarra´s Hospital Complex	848 42 22 22	Irunlarrea St. Nº3
Tafalla´s Medical Center	948 70 32 36	Sangüesa Avenue Nº19
Carcastillo´s Health Center	948 72 58 33	Pósito St. Nº6
Ambulances	112	

6th The Work Head shall order and is responsible for the installation of the preceding label in the following places of the work:

- Access to the work itself.
- In the construction office.
- In the staff's toilet locker room
- In the dining room
- In sheet size Din A4, inside each first aid medicine case.

This obligation is considered a fundamental condition for achieving the effectiveness of health care in the event of a worker accident.

5.3.IMMEDIATE COMMUNICATIONS

The Works Head, and in his absence, the Work Manager, and in the absence of both, the Head of Safety and Health, are obliged to carry out the actions and communications that are contained in the explanatory table below, which considers the key actions for the prevention (Table 33).

Table 33: Communication protocol depending on the type of accident at work

IMMEDIATE COMMUNICATIONS IN THE EVENT OF A WORK ACCIDENT
Mild accidents. To the Coordinator in the field of Safety and Health during the execution of the work. To the Optional Directorate of the work To the Labor Authority
Serious accidents. To the Coordinator in the field of Safety and Health during the execution of the work To the Optional Directorate of the work To the Labor Authority
Fatal accidents. To the court of law To the Coordinator in the field of Safety and Health during the execution of the work To the Optional Directorate of the work To the Labor Authority

5.4.ADMINISTRATIVE ACTIONS

The Work Head, in the event of an accident at work, will carry out the following administrative actions:

- Accidents without work leave: will be compiled in the "official worksheet of work accidents occurring without medical leave", which will be presented in the "managing entity" or "collaborator", within the first 5 days of the following month.
- Accidents with work leave: they will originate an official part of accident at work, which will be presented to the managing or collaborating entity within 5 working days, counted to be paid from the date of the accident.
- Serious, very serious and fatal accidents, or affecting 4 or more workers: they shall be communicated to the Labor Authority, telegraphed, by telephone or fax, within 24 hours from the date of the accident.

5.5.SIGNALING

a) OCCUPATIONAL RISK SIGNALLING

This signage shall comply with the content of Royal Decree 485/1997 of April 14th, which is not reproduced by documentary economy. It develops specific provisions on occupational risk as far as the signaling is concerned according to Law 31 of November 8th, 1995 on Occupational Risk Prevention.

RULES FOR THE ASSEMBLY OF SIGNALS:

1st The signals shall be located as described in the Plans (which will be developed in the final Safety and Health Report carried out by the Contractor) and according to the characteristics of the work.
2nd The location change of each signal is expected at least monthly to ensure maximum effectiveness.
3rd The signs will remain covered by opaque elements when the risk, recommendation or information they announce is unnecessary and is not appropriate for any reason to withdraw them.
4th They shall be installed in the places and distances indicated in the specific signaling plans.
5th A cut of cleaning and maintenance of signals will be maintained permanently, ensuring its effectiveness.

b) ROAD SIGNAGE

This signage will comply with the new "Circulation Code" and the content of the Road Rule 8.3-IC, Signage, beaconing, defense, cleaning and completion of fixed works outside the village" promulgated by the "MOPU", which are not criticized by documentary economy.

RULES FOR THE ASSEMBLY OF SIGNALS:

1st The signals shall be placed according to the needs of the work as indicated of the Report of this project.
2nd The change of location of each signal is planned at least monthly to ensure maximum effectiveness.
3rd Signals shall remain covered by opaque elements when the risk, recommendation or information they announce is unnecessary and is not appropriate for any reason to withdraw them.
4th They shall be installed in the places and distances indicated in the specific signaling areas.

5th A cut of cleaning and maintenance of signals shall be maintained permanently, ensuring its effectiveness.

6th In any case and despite the provisions of the road signs, account shall be taken of the comments and possible recommendations made by the competent bodies of the different administrations throughout the completion of the work and for their specialization, those of the Policía Foral.

6. INCIDENTS BOOK

The Incidents Book, which must always be kept on the work, shall be in the possession of the Safety and Health Coordinator in the field during the execution of the work or, where the appointment of coordinator, held by the Optional Directorate, is not necessary.

7. DELIVERY CONTROL OF PERSONAL PROTECTIVE CLOTHING

Each worker receiving personal protective clothing shall sign a document, which is justified in its receipt. The document will specify the obligation of its use for the jobs specified in that document.

8. ACCIDENT CONTROL RATES

An accident statistic shall be carried out on a monthly basis, taking as a starting point the following indices:

1.- Frequency index.
Number of accidents causing time off work per million hours worked.
2.-Age rating.
Number of days lost by accidents with casualty for every thousand hours worked.
3.- Average duration of disability.
Number of days lost for every accident with casualty.

9. WORKERS TRAINING

All workers will be aware of the risks involved in their work, as well as the behavior to be observed and the use of collective and personal protections, regardless of the training they receive. This information will be given in writing.

The rules shall be established in writing when risks, accidents or any type of incident are detected. Each subcontractor on the job will be given, before work begins and with acknowledgement of receipt, a copy of the part of the Safety and Health Plan that is in place, in addition to establishing a representative of the subcontractor in the field of Safety and Health.

10.STANDARDS FOR CERTIFICATION OF SAFETY ELEMENTS

Once a month, the construction company will extend the valuation of the items that, in matters of Safety and Health, would have been carried out in the work. The valuation will be made in accordance with the Plan and according to the prices contracted by the Property. This value will be approved by the Work Director, because without this requirement it cannot be paid by the Property.

The payment of the certifications set out in the previous paragraph shall be made as stipulated in the construction contract.

The budget of the Safety and Health Plan will take into account the Safety and Health Measures, the auxiliary means and installation of all the structure needed to meet the requirements established in this Basic Safety and Health Report. For that reason, the Promoter of this work has considered to allocate 20000 € to comply with all the requirements showed and exposed in this document.

In case of implementation or activities not provided for in the work plan, they will be defined and the corresponding price will be awarded to the contractor and proceeded for payment.

In the event of a price review, the contractor will communicate this fact, in writing, to the Property, having obtained the prior approval of the Work Director.

11.CHANGES IN THE SAFETY AND HEALTH PLAN

Any modification to the content of this Basic Safety and Health Plan, due to subsequent modifications to the construction process, will be reflected in a series of appendixes that will come to complete the Work Plan.

The aforementioned appendixes must be approved by the Safety and Health Coordinator during the operating phase of the work.